



Fencing FACTSHEET



Order No. 307.050-1
Revised December 2015

NEW FENCE CONSTRUCTION Types of Fences, Planning and Legislation

This Factsheet outlines the points to think about when planning new fence construction.

TYPES OF FENCES

Fences are usually categorized by either the type of material used (e.g., barbed wire fence), whether or not it is electrified, or by its intended use (e.g., snow fence).

All-Wood Fences

These traditional fences have been built of materials close at hand, such as trees removed when clearing the fence right-of-way, with labour being the main cost. With rising labour costs, a wood/wire fence may be more cost-effective.

Fences such as snake rail, log worm, log and block, buck and pole, jack leg, russell, horse and rider are built of wood and rest on the ground. Most use few or no nails; some use wire to hang the rails.

Post and rail designs require setting wood posts in the ground and nailing on horizontal wood rails. Well-constructed post and rail designs are used for corral and feedlot fences because of their strength. In other cases, these designs may be chosen for their aesthetic value.

Properly constructed all-wood fences can have low annual maintenance costs. However, depending on climatic conditions, rotting will occur at ground-contact locations and on unpeeled rails, limiting fence life. Peeled rails and preservative treatment for posts and ground blocks should be used.

Some log fence designs require a wide right-of-way to accommodate the zigzag of the logs. This extra area may add to the right-of-way preparation costs and remove more land from production.

The following briefly describes four common all-wood fences most often used for cattle and horses. Design information is available in Factsheet 307.260-1 entitled ***Livestock Control – Non-electric Fence Designs***. These wood fences are not generally built for small livestock such as sheep or swine.

Post and Rail Fence. These fences are the most common of all wood types in general use. If an appropriate design is used, they are effective for most livestock. For larger livestock and in concentrated areas such as corrals and feedlots, large posts and sturdy lumber (often full, unmilled thickness) are used.

Snake Rail or Log Fences. These all-wood fences are formed without supporting posts by rails or logs horizontally in a self-supporting zigzag formation. The bottom rail rests on a short ground block. The fence may be three or four logs high depending on material size. Logs are notched where they interconnect.

This style of fence is effective for cattle and horses. For the large sized breeds use appropriately larger diameter logs. Most cattle will require a minimum 6-inch diameter log for a four-log fence, larger diameter for a three-log fence.

The base block should be fully peeled to reduce rotting and preferably treated with **preservative**. All logs should be, as a minimum, scored on two sides so the bark will fall off. The top two logs may be wired together at the ends to ensure the top log is not easily knocked off. Panels or sections are usually 14 feet long.

Log and Block Fence. This type of fence is constructed similar to the snake log fence but the logs run parallel to the fence line rather than in a zigzag shape. The blocks are set between each set of logs with the panels offset slightly from each other. Panels or sections are usually 14 feet long.

Russell Fence. This type of fence is constructed by suspending rails between crossed log supports. Wire is used to tie the supports together and to hang the rails. Tie poles run from the support down to ground at mid-panel and are wire-tied to the bottom rail. Four to five rails are used depending on their size. Panels or sections are usually 12 feet long.

Steel Wire Strand Fences

These fences are the most commonly constructed agriculture fences in B.C. Posts are either dug or machine driven or vibrated into the ground, and individual strands of wire are stretched and stapled to the posts. Various designs are used for many types of livestock, with woven wire often used for smaller sized animals. Refer to Factsheet 307.260-1 entitled **Livestock Control – Non-electric Fence Designs**. While the majority of posts are wood, other materials such as steel and concrete are used in special circumstances. Refer to Factsheet 307.110-1 entitled **Fence Posts – Materials, Installation and Removal**.

To achieve long life, materials such as preservative-treated wooden posts and galvanized wire are used. Combined with good construction methods, these types of fences can be expected to last 25–35 years or more, depending on the climate.

Two common types of wire are used: barbed wire (single or double strand) and, more recently, single strand high tensile smooth wire (htsw). Designs having from 4 to 8 strands (nonelectric) and 1 to 8 strands (electric) for a variety of livestock are used. Electric fences may also use a lightweight type of wire or tape. This is a braid of fiberglass and metal wire strands suitable for temporary or moveable fences. Refer to Factsheet 307.100-1 entitled **Commonly Used Wire for Agricultural Fences** and Factsheet 307.100-2 entitled **Fence Wire: Dispensing, Stapling, Joining, Tying, Tensioning and Grounding** for a discussion on types of wire and wire handling.

As the wire is tensioned, brace assemblies must be built at regular intervals to anchor the wire strands. These assemblies become an important part of the fence system with several designs and construction methods. Refer to Factsheet 307.220-1 entitled **Brace Assemblies for Wire Fences – What they Are, How They Work, How to Construct Them** and Factsheet 307.220-2 entitled **Brace Assemblies for Wire Fences – End, Inline and Change of Direction Braces**.

Where livestock pressure is greater or where posts are placed far apart, spacers or droppers are placed on the wire strands for improved fence effectiveness. Also called stays or dummies, these vertical members perform some of the functions of posts (such as locating the wires and keeping them spaced) normally at a lower cost. Refer to Factsheet 307.100-3 entitled **Droppers for Wire Fences**.

Steel Woven Wire Fences

These fences are used for livestock or wildlife either due to the smaller size of the animal or because greater security is required. For instance, sheep are easier to fence with woven wire than with individual wire strands. For game farm animals such as fallow deer, woven wire is required on the farm perimeter to ensure containment.

Woven wire fences are generally more expensive than individual wire strand fences and require somewhat different construction and maintenance practices. Woven wire is available in a variety of configurations relative to the number and spacing of horizontal and vertical wires. Refer to Factsheet 307.100-1 entitled ***Commonly Used Wire for Agricultural Fences***.

Polymer Strand and Grid Fences

Polymers (essentially plastics) for fences are available as a pure strand, a grid and as a polymercoated steel wire strand. Uses for this material include snow fences, bird barriers, safety fences, horse fences, etc. Polyvinyl chloride (PVC) “rails” or “boards” that are mainly for residential fences have been used for farm fences, although they may be more expensive than traditional fences. Refer to Factsheet 307.100-1 entitled ***Commonly Used Wire for Agricultural Fences***.

Electric Fences

These fences are constructed to form a psychological rather than a physical barrier to control animals. Because this can usually be achieved with fewer materials than the physical barrier of a nonelectric fence, construction costs are often lower.

The electricity to energize the wire is delivered by fence controllers or energizers that are powered by either utility power or batteries. Utility power energizers are selected for fences where alternating current (AC) electricity is readily available. Battery power energizers are used for more remote fences. Solar panels are available to “trickle charge” the battery to extend its charge when the sun is shining. Refer to Factsheet 307.310-1 entitled ***Electric Fence Controllers***.

Electric fencing requires knowledge of the electric circuit that is being constructed. This is often the area where problems occur, resulting in poor electric connections, inadequate grounding systems, etc. Refer to Factsheet 307.300-1 entitled ***Introduction to Electric Fencing***.

An electric fence also requires good maintenance to ensure continued effectiveness. Frequent fence checks and maintenance are required, resulting in costs that may be higher than for nonelectric fences. Some of the construction savings of electric fences may be reduced by this additional annual maintenance cost. Refer to Factsheet 307.320-2 entitled ***Training, Testing and Trouble Shooting – Living with An Electric Fence***.

Special Fences

Unique fence designs such as windbreak fences, high-snowfall-area fences and snow entrapment fences are detailed in Factsheet 307.230-1 entitled ***Wind and Snow Fences***.

Wireless Fences. Research is proceeding on the use of electronic technology to replace the need to erect any type of fence. So-called “invisible” fences are currently available for residential fencing of pets. A buried perimeter wire acts as an antenna to transfer a signal from a house-based transmitter to an animal collar, alerting the animal it has reached its boundary.

The adaptation to livestock is to have a small implanted “chip” which receives the transmitted signal and “stimulates” the animal for control. These wireless fences may become cost effective and practical, especially for temporary or movable needs.

PLANNING A FENCE

The following quotes have often been applied to a general lack of planning:

"They didn't plan to fail, they just failed to plan."

"If you don't know where you're going, any road will get you there."

A fence is nothing more than a management tool which will be most successful when properly planned. In fact, an unplanned or poorly planned fence may create more problems than it solves. Fences should be planned as part of an overall system for a farm or ranch. For instance, when fencing a grazing area, the fence must be planned in conjunction with both the water and the forage supply. Planning should be done in two steps:

Step 1. Choose the location, arrangement and type of fence. There are a number of things to consider but generally all fit into the six factors listed below.

Step 2. Choose the fence design and plan the logistics of the fence construction.

As a footnote to planning, there is an old saying that “*It’s better to sleep on what you’ve planned than be kept awake by what you’ve done.*” A second look at the fence plan before construction starts will be the easiest time to locate and correct problems.

Factor # 1 : Purpose of Fence

First of all, why is the fence required? The purpose will determine the design and materials used. The primary purpose of the fence may be obvious but it may have secondary uses that could be optimized at this planning stage. For instance, a range drift fence could be upgraded in one area to serve as a breeding pasture fence. Good initial planning will ensure the best use of materials.

While the fence may be primarily for livestock or crops, also consider the “people use” associated with the fence: Have gates been located for good vehicle access? Have people-gates been considered for safety and convenience?

Factor # 2 : Type of Animal(s)

A fence plan may indicate that the fence will affect one or more types of animals. A cattle grazing fence may also be required to allow passage of deer; a game farm fence must contain stock and repel predators; cattle and sheep may use the same pastures. These fence needs can be dealt with at the planning stage rather than after construction.

Factor # 3 : Site Information

Having determined the purpose of the fence and the animals affected, the next factor is the site conditions, which will affect both the location of the right-of-way and the materials used. Site conditions may be fixed, semi-fixed or changeable.

Fixed Items

Topography. Use the lay of the land wherever possible for efficient fence construction. Make use of natural boundaries, if possible, but be aware that they may be removed (future logging, road building activities, etc.). Watch for possible soil erosion on steep slopes. Fence grazing areas with livestock movement patterns in mind so as not to create more problems than the fence solves. Plan water and feed availability when fencing rough terrain. Air photos may be useful at this stage.

A site’s slope and north/south exposure will influence forage growth. When planning fences for a grazing system, aim for fields that are similar in slope, soil and forage type for best results.

Soil Type. This will determine the ease of post placement and, to some extent, the design of end braces. Light soils will be easy to drive posts in but will provide less resistance to brace failures. Where possible, plan to locate braces in firm soil. Hard and/or stony ground may require a fence design using a wider post spacing, dug-in posts or, in some cases, steel posts.

As soils affect crop growth, plan fenced grazing areas with the forage in mind. Soil type may restrict or influence right-of-way construction (i.e., risk of erosion).

Snow. Fences in areas of heavy snow or blowing snow will require special designs such as lay down fences. In extreme cases, material selection may be limited.

Vegetation. Forested areas will require a fence design capable of withstanding windfalls. Fences along stream banks should be set back to protect *riparian* vegetation. Electric fence hot wires may ground out in areas of heavy vegetation.

Wildlife. Fence designs may need to be modified in areas of wildlife movements. For instance, fence heights may have to be reduced, or wooden top rails or nylon ribbon used on wire cattle fences to provide deer and moose a visual height they can safely jump.

Recreation. Crown land with high recreation use may require fence designs compatible with both livestock and human use.

Legal Boundary. Fences on legal boundaries may be affected by government legislation. A fence placed in trespass may have to be removed!

SEMI-FIXED ITEMS

Accessibility. Fence access is important for construction and maintenance. Good access will help to maximize benefits and minimize labour costs. In forested areas, the fence right-of-way should allow access to both sides of the fence. This is important during construction and later for maintenance and livestock movements.

Water. Fences across streams may require special designs such as floodgate sections. Fencing to lake shores may require low-water-level extensions. Note any seasonal runoff concerns that would affect the fence in an otherwise dry gully, for example. Locate end braces in firm soil away from flooded land.

Visual Impact. Some sites may have high visibility and a fence design and location may be chosen to reduce the visual impact. Such sites may be near highways, towns or recreation areas. These sites may require lower impact right-of-way preparation.

CHANGEABLE ITEMS

Forage. Fence location should allow good management of different types of forage. For instance in grazing areas, the fence line should be located to separate native and tame vegetation.

Existing Fences. These may or may not fit into the new plans, but they should not limit planning at this stage. The best overall plan should be considered.

Factor # 4 : Permanent or Temporary Fence

Permanent fences are defined as those which are built of durable materials, are not expected to be moved, and will last 25 to 30 years or more. These would be boundary fences, corral fences, cropland fences, etc.

Temporary fences are defined as those which, while using quality materials, are built for either shorter life or, more commonly, built to be moved. These would be seasonal fences in grazing areas, perhaps electrified for controlled grazing or fences which need to be relocated from year to year for other reasons.

Factor # 5 : Electric or

Electric fences are constructed to form a psychological barrier to control livestock and wildlife. They may have a low material and labour construction cost but may

Nonelectric Fence

require additional yearly upkeep to maintain the electrical circuit. They require basic knowledge of electricity for construction, maintenance and troubleshooting. Electric fences can be either permanent or temporary designs usually with individual wire strands. **Barbed wire should not be electrified; smooth wire is preferred.** A person or animal may be caught in the barbs and not escape the electrical shock. Nonelectric fences are fences constructed to form a physical barrier to control livestock and wildlife. In contrast to electric fences, nonelectric fences generally require more material and labour construction costs but may have a low annual maintenance cost.

Both electric and nonelectric designs may be used on the same fence.

Factor # 6 : Other Considerations

Environmental (Undesirable). Will the fence have any specific negative impacts on the environment? If so, how can they be reduced or eliminated? For instance, fences should not be located where they will encourage livestock impact on a riparian area; right-of-way disturbance may cause noxious weed problems.

Environmental (Desirable). Livestock control fences may allow environmental improvements, such as exclusion from streams. Fences can change the effect wind and snow has on a farmstead or livestock by reducing the wind velocity and controlling snow drifting.

Economics. If the proposed fence fulfills the intended purpose, is there sufficient “payback” to cover the installation cost? Are there other layout choices or can a less expensive design be used?

Labour Versus Capital. Some decisions will depend whether labour or capital is most appropriate to spend on a fence. For example, some fence designs have low materials costs but require more labour to construct.

Future Options. Consider future uses for areas being fenced. Can the fence be ‘upgraded’ for more intensive use in the future?

LEGISLATION AFFECTING FENCES

The Trespass and Livestock Acts

While there are no Acts specific to fencing, these two Acts mention fences and the need to fence. The **Trespass Act** and **Livestock Act** both define “enclosed land”:

Trespass Act: “enclosed land” includes land that is:

- surrounded by a lawful fence (defined in Regulations)
- surrounded by a lawful fence and a natural boundary, or a natural boundary alone
- or, posted with signs prohibiting trespass

Livestock Act: “enclosed land” means land that is surrounded by a natural or man made barrier sufficient to exclude or contain livestock.

In the **Trespass Act**, a trespasser is defined as “a person ...” The **Trespass Act** is a “people” act and is not meant to deal with livestock. However, it states that one of the ways to enclose land is with a “lawful fence,” defined in the Regulations in terms of what could be considered livestock fences. These “lawful fence” designs get confused with the **Livestock Act**, which deals with livestock control but defines **no** fence design, only “any man made barrier sufficient to contain or exclude livestock.”

Livestock and Land Owners – the Legal Requirement to Fence

The **Trespass Act** Regulation definition of a “lawful fence” is many years old. Only the actual fence designs stated in the regulations can be used (which curiously are different for different areas of B.C.!). It does not include current fence materials or technology such as high tensile smooth wire or electric fences and requires a wire gauge for woven wire fences that is not commonly used. Also, the required fence height of 54 inches is not common for most livestock and not “wildlife friendly”.

The **Trespass Act** states that “*unless otherwise agreed, owners of adjoining land in a rural area shall make, keep up and repair the lawful fence between their respective land, and each is liable to the other for half of the cost* ” (not binding on the Crown).

Section 3 of the **Livestock Act** allows a livestock owner to have livestock at large (roaming free of fence confinement) in Livestock Districts (subject to the **Range Act** and any local bull control rules). Much of B.C. has designated Livestock Districts except Northwest B.C., West Kootenays, Vancouver Island and the Lower Mainland (livestock districts also allow the establishment of bull control areas so different Crown land permittees can control their livestock breeding on rangeland).

This livestock at large (or so-called “open range”) allowance is the reason for the arguments that sometimes occur between the livestock owner and adjacent land owners when no fences (or inadequate fences) separate the two. **In Livestock Districts, the land owners who do not want other people’s livestock on their land must fence them out.**

Section 6 of the **Livestock Act** however, allows the establishment of Pound Districts that essentially reverse the privileges of Livestock Districts. **Livestock at large in Pound Districts are subject to capture** (unless permitted by this act or the **Range Act**). This makes it a requirement of the livestock owner to fence in their livestock.

Section 10 of the Act states that “*the owner of livestock is liable for damage caused by the livestock where the livestock is at large contrary to this Act ...*” but, “*a proceeding shall not be brought for trespass where livestock strays into unenclosed land that is located outside a pound district.*”

For more information about livestock and pound districts, contact the Ministry of Agriculture.

Our advice? For on-farm, non-boundary fences use the designs and methods in Ministry of Agriculture factsheets. For boundary fences, carefully consider the “lawful fence” designs. Unless neighbours otherwise agreed, “lawful fence” designs may have to be used where one neighbour wants the other to equally share boundary fencing costs. For trespass (people) concerns, fence or post the boundary as by the **Trespass Act**.

Motor Vehicle Act Regulations

The **Motor Vehicle Act Regulations** have two references to livestock and highways:

Clause 19.07 (1) states that “... *except for crossing at an intersection, use of any highway named in Schedule 1 by the following is prohibited at all times: ... (b) livestock, as defined in the **Livestock Act** ...*” (This is not usually a problem as these are the freeways)

Clause 19.08 states that “... *no person, being the owner of or having control of any livestock as defined in the **Livestock Act**, shall permit the livestock to be upon any highway named in Schedule 2, except for crossing the highway from one place on a farm to another place on the same farm ...*” (These highways are often in agricultural areas and fencing along their rights-of-way is of concern to producers)

Details of policies are not given here as they are subject to change. However, specific policy relates to private land, private rangeland, Crown land under grazing, etc., as to the materials and construction contribution from the Ministry.

Minor Roads. All costs associated with the construction and maintenance of a fence are the responsibility of the landowner.

Lands Adjacent to Schedule 2 Highways. Where existing fences are altered or disturbed and where fences are required in new construction, usually an existing enclosed area, the Ministry is responsible for all construction costs. On completion, fence maintenance falls to the landowner unless provided by Order in Council.

It is the livestock owner's responsibility to ensure the **Motor Vehicle Act Regulations** are adhered to. This means the landowner or lessee is responsible for the maintenance of the fences (i.e., to ensure livestock are kept off Schedule 2 highways). Maintenance means the day-to-day repairs as well as the provision and installation of replacement materials.

The repair or renewal of any damaged or deteriorated fencing that can be attributed to poor range management practice will be the responsibility of the livestock/land owner.

When the repair or renewal of fencing is the responsibility of the Ministry, the owner of the livestock or land is expected to arrange for temporary repairs to a fence or take other measures to prevent livestock from being at large on the highway until more permanent repairs are arranged for by the Ministry.

Liability of an owner of livestock or land for livestock straying onto a scheduled highway and causing an accident is determined by the ordinary rules of negligence. This means the owner must take reasonable care to control the livestock.

For policy details please contact your local Ministry of Transportation and Infrastructure office.

Animal Health Act

The Game Farm Regulation under the **Animal Health Act** refers to containment of game animals on a farm but specifies no design requirements. Policy has been to approve perimeter fence designs such as shown in Factsheet 307.271-1 entitled **Deer Farm Perimeter Fence** for reindeer and fallow deer. Bison fence designs have typically been cattle fences, or upgrades of them.

FOR FURTHER INFORMATION CONTACT

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Fencing FACTSHEET



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FENCE CONSTRUCTION SAFETY

This factsheet outlines both Workers' Compensation Board and general fence construction safety concerns.

CONSTRUCTION SAFETY

WorkSafeBC Requirements

Numerous safety concerns are associated with fence construction. Many are related to either the rugged terrain or the type of equipment used. Specific practices to minimize dangers are outlined in the *Occupational Health and Safety Regulation* issued by WorkSafeBC.

Fencing Equipment

The numbered items below refer to specific agriculturally-related sections within the Occupational Health and Safety Regulation.

Post-Hole Diggers

Clause 28.20. A post-hole digger must have:

- (a) the tractor or machine brakes set before digging
- (b) shear bolts as specified by the manufacturer
- (c) a hold-to-run control (deadman switch) when operated as a hand-held unit

Post Drivers

Clause 28.21. A worker operating post drivers must:

- (a) lower the hammer and stop the engine when adjustment or maintenance is required
- (b) if necessary for safety, steady the post with a steady fork or guide
- (c) lower or block the hammer when the machine is not in use

Chain Saws (Standards)

Clause 12.72. A chain saw must:

- (a) meet the requirements of *CSA Standard Z62.1-95, Chain Saws*
- (b) have a chain brake that activates automatically upon kickback regardless of the position of the power head or operator's hands.
- (c) A chain saw manufactured before January 1, 1999, with a guide bar exceeding 66 centimetres (26 inches), measured from the top of the cutters at the bar tip to the point of the "dogs" or "bumper spikes", is exempt from the requirement for a chain brake.

Chain Saws (Stopping Chain Movement)

Clause 12.73. A chain saw chain must be stopped before the saw operator moves from cut to cut, unless the next cut is in the immediate area and the saw operator can safely move to the next cutting position.

Chain Saws (Operation)

When using a chain saw, clothing should be worn which protects the operator from scrapes and scratches and allows freedom of movement. Read the WorkSafeBC brochure entitled *Chainsaw Safety* to find out more about maintenance, chain filing, refueling, and first aid.

General Protection for Workers

Other general items of safety concern are also covered in the Occupational Health and Safety Regulation as shown below. The clause numbers correspond directly with those in the regulation. Full details are specified in the regulation.

Safety Footwear

Clause 8.22. Footwear should be appropriate to the working situation. Examples could include the requirement to wear leather, puncture-resistant soles or steel toes.

Hand Protection

Clause 8.19. Hand protection should be worn as conditions require.

Eye Protection

Clause 8.14. Properly fitting safety eyewear appropriate to the conditions of the workplace must be worn.

Clause 8.15. Prescription safety eyewear must meet the requirements of CSA Standard CAN/CSA-Z94.3-92, Industrial Eye and Face Protectors.

Noise Exposure

Noise Limits

Clause 7.1. An employer must ensure that a worker is not exposed to noise levels above either of the following exposure limits:

- (a) 85 dBA Lex daily noise exposure level
- (b) 140 dBC peak sound level

Noise Standards

Clause 7.3. The noise exposure measurement must be performed in accordance with CSA Standard Z107.56-94, Procedures for the Measurement of Occupational Noise Exposure.

Moving Machinery

Several concerns associated with the operation of moving machinery are highlighted below. Loose clothing should be avoided around rotating parts, in particular.

Equipment Guarding and Agricultural Tractors

The Occupational Health and Safety Regulation also refers to tractor safety concerns. Two of note in conjunction with fencing are as follows.

Power Take-Off Devices

Clause 28.16. At conspicuous locations near rotating shafts driven by power take-off devices, warning signs must be located specifying that shields must be kept in place.

Rollover Protective Structures (ROPS)

Clauses 16.22, 16.23, 28.38, 28.39, 28.40 and 28.41. The types of tractors and detailed standards for rollover protection are specified in these six clauses.

CONSTRUCTION SAFETY

General Concerns

Other general common sense safety concerns associated with fencing are highlighted below.

- Wear tightly woven, tough clothing that will not catch on the ends of wire.
 - Wear heavy duty, snug fitting gloves when handling treated posts.
 - Wear long pants and high ankle work boots with heavy soles and steel toes.
 - Wear safety goggles or eye shields when cutting or tensioning wire and driving nails or staples.
 - Wear a hard hat and ear plugs or earmuffs when operating a power post driver.
 - Never carry nails or staples in pants pockets; use a nail apron or tool bag.
 - Use proper shields on power equipment.
 - Keep children and livestock away from all fencing operations
 - When handling or working on chemically treated wood protect exposed skin (gloves, face shields, etc.).
 - Pick up all cut ends of wire, dropped staples and nails, etc. so they will not cause injury to other people or livestock.
 - Stop all fencing operations during electrical storms.
 - Install proper ground wires to wire fences as soon as they are erected.
 - Wire is an excellent conductor; be careful around overhead power wires.
 - Care must be taken when handling and cutting all fence wire, especially high tensile wire. While low tensile or 'soft' wire is relatively 'limp' when cut, high tensile wire is extremely 'springy' and may injure the unsuspecting worker. Both ends of the cut wire must be restrained or at least the worker must be aware of where the loose cut end may go. To avoid the wire curling up or rolling back to its' supply drum, stick the wire end into the ground 3 or 4 inches to restrain it.
 - High quality cutting pliers are required to allow high tensile wire to be cut with a 'normal' effort. Standard cutters will require too much effort to cut this wire.
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COMMONLY USED WIRE FOR AGRICULTURAL FENCES

This factsheet describes wire used for agricultural fences, including single strand wire, woven wire, electric fence wire and special wires. It also has a section on the properties of steel used for fence wire.

BARBED WIRE

During the period from 1790 to 1873, there were 652 U.S. patents issued for fencing-related inventions. However, at a county fair in De Kalls, Illinois in 1873, a patented device of “Wooden Strip with Metallic Points” was displayed. That quickly led to a local farmer, Joseph Glidden, to adapt this “armoured fence attachment” to wire and install the first section (66 feet) of barbed wire fence. Although earlier work was done elsewhere, Glidden is credited with starting the barbed wire industry with his US patent No. 157142 of “The Winner”, issued November 24, 1874, of a two strand wire with two point wire barbs. Many other patents on barbed wire followed; close to 400 patents exist with references to more than 700 wire varieties.

Initially it was the homestead farmer who popularized barbed wire and the open range cattlemen who fought against it. However, as settlement continued, cattle ranges were fenced as well. Barbed wire invention and manufacture coincided with the quick expansion of the West in the late 1800s.

Today barbed wire is commonly available as two strands of 12½ gauge wire with four-point barbs of 14 ga. wire spaced 5 to 6 inches apart. This wire is formed from low tensile steel with a breaking strength of about 950 pounds. Commonly the zinc coating is less than or equal to Class 1.

Barbed wire is sold in rolls of 1320 feet weighing approximately 80 pounds.

Pretensioning Required. During manufacture, two strands of wire are “twisted” together to form a single, double strand wire but these are not always pulled tightly together. For this reason, when constructing a fence using two strand barbed wire the two strands must be prestretched or pretensioned to ensure the fence wire performs as a single unit, not as two separate wires. This involves tensioning the wire up to about 600 pounds and then relaxing to the normal wire tension of 250 pounds **before** stapling. Failure to pretension two-strand barbed wire will result in loose fence wires a year or two after construction.

High Tensile Barbed Wire

Barbed wire is also manufactured from high tensile (ht) steel in either one or two strands. Two strand 15½ ga. ht barbed wire has the same breaking strength but about one half the weight of common barbed wire.

HIGH TENSILE SMOOTH WIRE (HTSW)

Various types of barbless, smooth wire have been used over the years, many not meant for fencing. In the early 1980s a smooth wire was introduced into BC that was specifically designed for fences. This wire is a barbless (smooth), single strand fence wire produced from a high tensile steel. The standard size is 12½ gauge with a minimum breaking strength of 1,350 pounds. Rust protection is to Class 3 galvanizing for long life. It is available in 100-pound rolls containing about 3,750 feet on a drum suitable for dispensing the wire.

High tensile smooth wire (htsw) is used in fencing to overcome some of the disadvantages of barbed wire, especially that of low strength. With the higher tensile and yield strengths of htsw, there is also a greater amount of elasticity. This produces a fence that can be subjected to greater loads without permanently stretching the fence wires or breaking them. These strength advantages are obtained without increasing the diameter of the wire, only increasing the grade of steel.

As expected, these advantages are accompanied by some disadvantages when compared to low tensile steel wire (common barbed wire). These two wires are compared in Table 1. With experience, workers find htsw is easy and quick to work with but is quite different from low tensile barbed wire.

WOVEN WIRE

Standard wire strand fences are often not effective on small livestock or aggressive predators unless droppers are spaced very close together. To overcome this, wire is available that has been manufactured with vertical wire “droppers” woven into the horizontal line wires. This forms a one piece fence wire fabric that can be rolled out and installed on posts.

Types of Woven Wire Fabric

Six general types of fabric are available, five steel and one “plastic”. Steel fabrics are categorized by the method used to secure the joint where the verticals intersect the horizontals.

Steel Woven Wire

These first two steel woven wires are commonly used in agricultural fences:

Hinged Joint The vertical is composed of separate wire pieces that are twisted together at each horizontal. This is a very flexible fabric. Refer to Figure 1.

Knotted Joint The vertical is one piece and knotted to each horizontal with separate knotting wire. This is a semi-rigid fabric. Refer to Figure 2.

The following three steel woven wires are **not** commonly used in agricultural fences:

Chain Link More expensive and not used for standard agriculture fences.

Soldered Joint This light wire fabric ("chicken wire") is not covered here.

Welded Joint This is a very rigid fabric and not normally used for agricultural fences.

Plastic Woven Wire

Polymer Grid A specialty product with various fence uses (refer to Special Wire, page 6).

Table 1 COMPARISON OF HIGH TENSILE SMOOTH WIRE AND BARBED WIRE

Wire Description	High Tensile Smooth Wire	Barbed Wire
Wire type	single strand 12½ ga.	double strand 12½ ga.
Tensile strength of steel	high (to 200,000 psi)	low (60,000 psi)
Breaking strength (min.)	1350 lb	950 lb
Relative brittleness	high	low
Relative elasticity	high	medium
Standard rust protection	class 3	class 1 (class 3 available)
Standard roll weight	100 lb	80 lb
Standard roll length	3750 ft	1320 lb
Wire Characteristics		
Subject to breaking at nicks?	yes	no
Will transfer loads to braces?	yes, through loose stapling	some—but catches on post staples
Requires prestretching?	no	yes
Staple to posts before tensioning?	yes	no
Effort to cut	high	low
Recoil tendencies	high	low
Splicing joints	mechanical splice	knot
Tying–off at end posts	mechanical splice or knot	knot
Effort to knot	high	low
Ease to retension after repairs	easy	difficult—must pull staples
“Wear” on workers	low (smooth)	high (sharp barbs)

Comments:

- htsw is easy to pull out along the fence line; barbed wire catches on “everything”
- htsw is “alive” when cut (high recoil tendency) – use caution; barbed wire has low recoil tendency
- htsw single strand has less visibility than two strand barbed wire
- htsw will not cut workers or livestock as will barbed wire
- htsw load transfer to braces requires good brace construction
- htsw is suitable for multiple strand dispensing to speed construction

Identifying Steel Woven Wire

Steel woven wire is identified by a number system that describes the fabric. For example:

- 10/47/6** woven wire has
- **10** horizontal wires
 - a total height of **47** inch
 - vertical wires spaced **6** inches apart

This number may also be written as 1047-6 or 1047/6. Sometimes it is followed by the wire gauge if the horizontals and verticals are the same, as in 10/47/6 12½ for 12½ gauge wire fabric.

Woven wire is available with heavier wire for the top and bottom horizontals (the edge wires). Whereas 12½ gauge is standard for many woven wires, the edge wires are available in larger size of 9, 10 or 11 gauge. Some manufacturers stock a heavy fabric made entirely from 9 or 10 gauge wire or a fabric made with high tensile steel wires.

The vertical wires are available in two standard spacings; 6 inch and 12 inch. The choice depends on the size of the livestock. Be sure to consider both adult and newborn sizes; birthing areas for some livestock may require the smaller 6 inch spacing.

The horizontal wires are available in a wide range of numbers of wires and total heights depending on the fence requirements. From 7 to 20 wires are available in heights from 26 inch to 96 inch with most fabrics having a horizontal spacing that becomes progressively wider to the top. This spacing change varies between fabrics and manufacturers. Be sure to know the spacing before purchasing woven wire. Refer to Figures 1 and 2, page 5.

ELECTRIC FENCE WIRE

Electric fences are commonly constructed using steel wire strands (htsw only – barbed wire should not be electrified). This produces an effective fence, one that usually is permanently located. However, one use of electric fencing is for temporary or movable fences, especially in controlled livestock grazing. Although standard gauge steel wire can be used for temporary electric fences, special wires are available.

Steel Wire

Smaller size steel wire may be used for electric fences, especially movable fences. Gauges of 14 to 17 are available. Electrical resistance increases with smaller wires and visibility decreases.

Poly Wire

For movable fences, lightweight, easy to handle wire is an advantage. Poly wire is composed of stainless steel or aluminum conductors woven with brightly colored fiberglass strands. Permanent electric fences are not usually constructed with this type of wire. Poly wire has the following characteristics:

Advantages of Poly Wire:

- lightweight – 300 ft weighs approx. 1 lb
- easy to handle – does not kink; easy to wind up on a drum
- easy to join – simple knots are used (these may be points of high electrical resistance)
- well suited to intensive grazing systems requiring temporary, movable fences

Figures 1 & 2, below, illustrate typical knotted and hinged joint woven wire specifications. Note the mix of options, for example in Figure 1, the difference between 13/74 and 17/75 knotted joint fabrics.

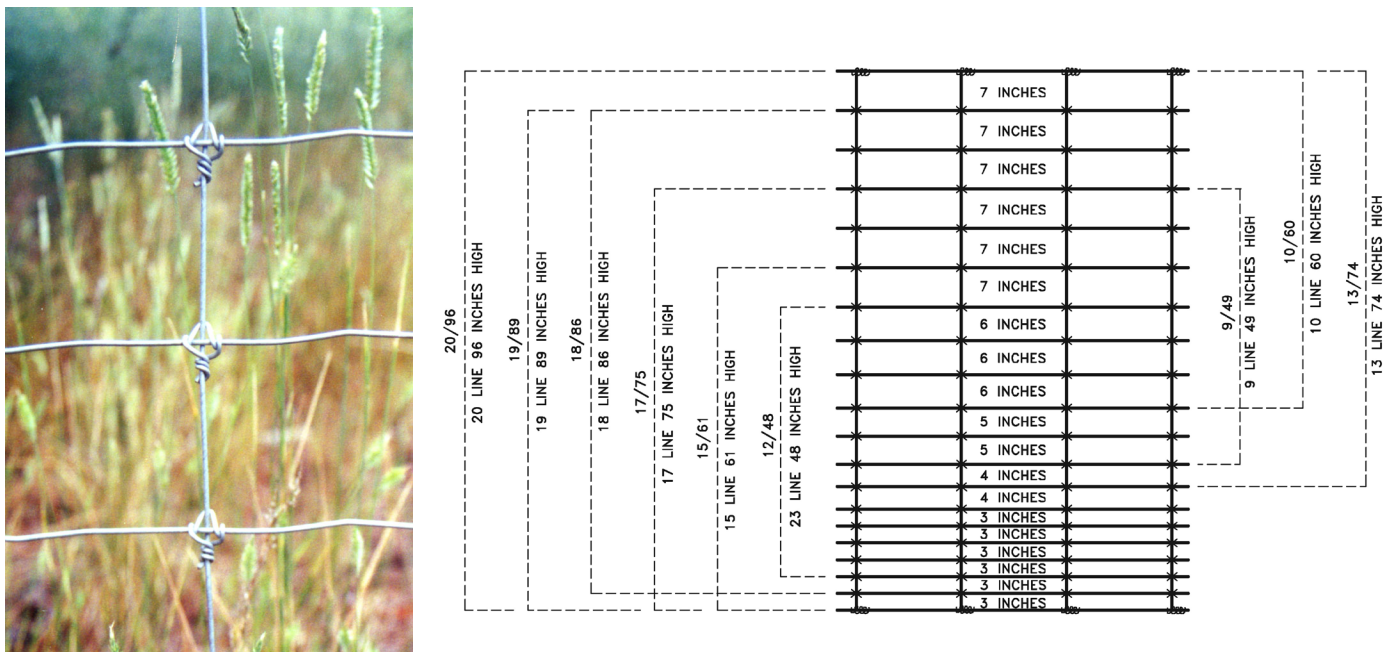


Figure 1 Typical Knotted Joint Woven Wire Specifications

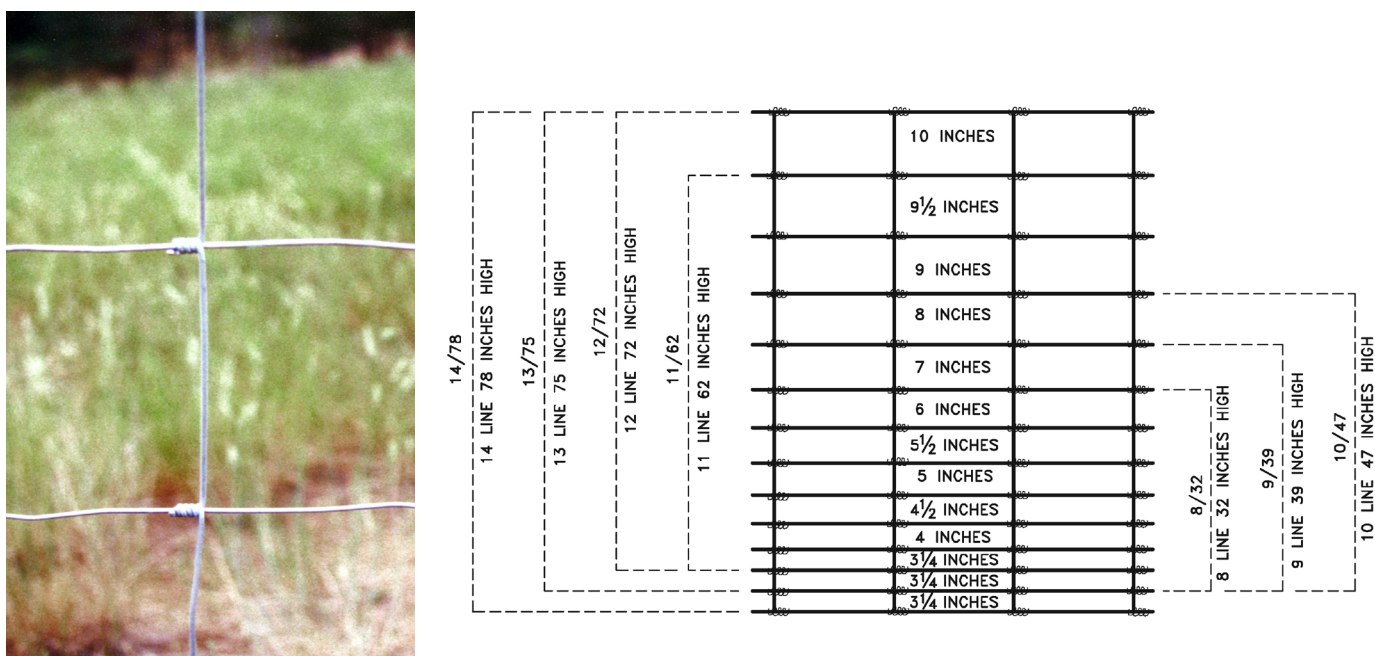


Figure 2 Typical Hinged Joint Woven Wire Specifications

Disadvantages of Poly Wire:

- cost – more expensive than steel wire
- high electrical resistance – due to small area of conductor limits fence to approx. 1000 ft
- low breaking strength – approx. 120 lb
- short life – due to sunlight deterioration; 5 year guarantee by some manufacturers

Poly wire is available as a braided wire (has appearance similar to poly twine) or as a tape (5/8 in. to 1–1/2 in. wide for greater visibility and strength). Poly wire is also available woven to form a net, sometimes used for grazing sheep. One manufacturer makes a net with solid plastic verticals for improved support. Poly wire may be chosen when ease of moving a fence is desirable (for controlled grazing, for example).

SPECIAL WIRE

Numerous special purpose wires are available. These may be more expensive but offer special features.

Aluminum Wire

This wire is used in electric fences for its good conductivity (4 times that of steel of the same gauge). It is more expensive and has lower strength than steel (1/4 of htsw). It is available in a braid form that is very flexible and used in temporary, movable fences.

Polymer Monofilament

This wire is a single strand of white 'plastic' and used mainly in horse fencing. Typically:

- diameter of 0.01575 inch (8½ ga.)
- weights about 1 lb per 100 feet
- breaking strength of 1,140 lb
- roll length of 2,500 feet
- tension not affected by normal temperatures
- good visibility

This wire is stapled tight to line posts or it may be threaded through drilled posts. It is joined or tied off with knots.

Polymer Coated Wire

This 'plastic' coated steel wire is available as a single strand or a two or three wire 'rail' coloured either white or black. It is used mainly for horse fences.

Polymer Grid Mesh

This all 'plastic' product is available in a wide range of thickness and mesh openings. It is used for everything from bird barriers to livestock, snow and safety fences.

This grid material is not nailed directly to posts but is set between the post and a wooden batten and then nailed.

Poly Vinyl Chloride

PVC posts and rails, while not actually “wires”, are available that assemble into a long life attractive fence. It is used mainly for horse fences and has an 'estate' quality that is priced above standard agricultural fences.

PROPERTIES OF STEEL USED FOR FENCE WIRE

Before wire became popular as a fencing material, fences were usually constructed from readily available local material, often wood. The introduction of wire meant that fences could be strung in areas where wood was not abundant. Wire is relatively light and strong; it can be strung at various spacings over rough terrain to suit a variety of livestock and wildlife; it can be re-used if so desired and has a long life.

The type of wire to use is dependent on the fence design. For instance, woven wire is used to contain deer on a deer farm, high tensile smooth wire could be used on a beef ranch and single strand electric wire could be used for strip grazing on a dairy farm.

The following are some properties and common terms that apply to steel fence wire.

Gauge

The gauge (ga.) of a wire is a standard measurement scale that relates to the wire diameter. The smaller the gauge number the larger the wire diameter (i.e. 9 ga. is a heavier wire than 12 ga.). Table 2 gives the wire diameters and weights of common U.S. steel wire gauges used for fence wires.

Table 2 can be useful for determining both the length of wire in a roll of known weight or the weight of a given amount of wire. Note that these figures are for a single strand of wire (smooth/barbless). To account for the weight of the barbs add approximately 10% to the bare wire figure.

Table 2 U.S. STEEL WIRE GAUGE FOR FENCE WIRE		
Wire Gauge (ga.)	Wire Diameter (inch)	Weight (Lb/100 ft)
9.0	0.1483	5.87
11.0	0.1205	3.87
12.0	0.1055	2.97
12½	0.0985	2.64
14.0	0.0800	1.70
16.0	0.0625	1.04

Example

Determining Length of Wire Knowing Weight

How many feet of wire are on a 100 lb roll of single strand 12½ ga. htsw?

- From table 5.3, 12½ ga. wire weighs 2.64 lb/100 feet
- Length of 100 lb = $100 \text{ lb} \div 2.64 \text{ lb/100 ft} = 3,788 \text{ ft /100 lb roll}$

(note: manufacturer specification typically lists 3,750 ft per 100-lb roll as minimum)

Example

Determining Weight of Wire Knowing Length

What does a standard roll of two strand 12½ ga. barbed wire weigh?

- Standard roll length = 1,320 feet
- From table 5.3, 12½ ga. wire (barbless) weighs 2.64 lb/100 ft (per strand); for the barbs, add 10%; $2.64 \times 1.1 = 2.9 \text{ lb/feet}$

Weight of 1320 ft roll = $1,320 \text{ ft} \times 2 \text{ strands} \times 2.9 \text{ lb/100 ft} = 77 \text{ lb}$

(note: manufacture specification typically list the roll weight at 78 lb.)

Tensile Strength and Breaking Load

The maximum tension for a given area that a wire can withstand is called its tensile strength and it is dependent upon the steel composition of the wire. This strength is calculated by dividing the maximum load or breaking load the wire can resist by the cross sectional area of the wire and is expressed in pounds per square inch. The breaking load is the load that will actually break the wire.

Standard steel used in barbed wire has a low tensile strength. The double strand 12½ ga. wire will break at a load of approximately 950 lb. High tensile smooth wire (one strand, same gauge) will break at a higher load of approximately 1,350 lb because of its higher tensile strength. Common barbed wire has a tensile strength of 60,000 psi versus htsw at up to 200,000 psi.

Fatigue Limit and Brittleness

The disadvantage of increased tensile strength is that the fatigue limit of the steel is lowered. This means the higher tensile strength wire is more brittle and subject to failure if it is bent sharply, kinked or nicked.

Elastic Limit and Yield

The maximum tension which can be placed on a wire, such that when the tension or load is removed the wire will return to its original length, is called the elastic limit of the wire. In fencing, this elastic limit should never be exceeded, otherwise the wires, once relaxed from the excess load, will be loose as the wire will have been permanently stretched. Normally, the elastic limit or yield is approximately 75% (60%–90% range) of the tensile strength. This means that although the breaking load of 2 strand barbed wire is 950 lb, the maximum load that will not cause permanent stretching is about 75% of 950 lb or about 700 lb. This then is the actual useable load capacity of the fence wire. For htsw this yield strength is about 1000 lb.

Elongation and Elasticity

Elongation is the change in length of a wire due to a load. Up to the elastic limit, elongation is proportional to the load and returns to zero when the load is removed. For a given load, a thinner wire will elongate more than a thicker wire, and is said to be more elastic. For instance, for every 100 lb. applied to 330 feet of 9 ga. wire it will elongate about 1 in; 12½ ga. wire (smaller in diameter) will elongate 2 in (the rate of elongation is only dependent on wire diameter, not wire composition). Because elongation can only be “useful” up to the yield strength of the wire, high yield strength fence wires will have more useful elasticity. This is the case when comparing standard barbed wire to high tensile smooth wire; the high tensile wire is more elastic having a higher yield strength. Or in other words, high tensile wire can accept higher loads before permanent stretching occurs.

Zinc Coating

Chemically applied zinc is a rust protective coating used on steel fencing wire. This galvanization is available in three levels or classes, the higher the level of zinc coating, the better the rust protection. For 12½ ga. fence wire refer to Table 3, below.

Table 3 ZINC COATING STANDARD FOR 12½ GA FENCE WIRE	
Class	Minimum Weight of Coating (oz/ft²)
1	0.30
2	0.50
3	0.80

From: ASTM Standards

The choice of which class of coating is required will depend on the environment the fence will be in; a dry climate requires less protection than a coastal climate. Table 4 indicates the approximate life expectancy of Class 1 and 3 (the two commonly used) galvanized 12½ ga. wire in different climates, and life expectancy once rusting starts.

Table 4 APPROXIMATE LIFE OF GALVANIZED 12½ GA WIRE			
Climatic Condition	Galvanized Class	Years until Rust Starts	Years after Rust Starts until Wire is at ½ Strength
Dry	1	11	50+
	3	30	
Humid	1	6	50+
	3	13	
Coastal	1	2	12
	3	6	

From: U.S. Steel “Max-Ten 200”/ASTM Standards

Coefficient of Linear Expansion

This term is used when considering the effects of temperature change on fence wire, and is defined as the change of length per unit length due to a temperature change. Steel wire contracts with temperature decreases and expands with temperature increases at a fixed rate. Contraction causes a force or tension to be exerted on the cross sectional area of the wire and is proportional to that area. The greater the area of the wire the greater the tension created by temperature change; for a given temperature change thin wires will have a smaller change of wire tension than heavy wires. This tension must be resisted by the braces.

For **one strand of 12½ ga. steel fence wire** (regardless of steel composition):

$$F = 2.6 \Delta T$$

where F = force or tension (lb) as a result of temperature change
 ΔT = temperature change (°C)

Note: This formula is an approximation of the force on the cross sectional area of one 12½ ga. strand only.

Example

Wire Forces Generated Due to Temperature Change

A fence with five single strands of 12½ ga wire is built in Kamloops in summer with temperatures at 30°C. The wires are tensioned to 250 lb each. What is the wire tension and total force exerted on the end braces in the winter at -30°C?

- Change in Wire Tension**

Wire tension change due to temperature drop:

$$F = 2.6 \Delta T$$

$$\Delta T = -30 \text{ to } +30 = 60^\circ\text{C}$$

$$F = 2.6 \times 60^\circ\text{C} = \mathbf{156 \text{ lb added tension (each strand)}}$$

New (winter) wire tension: 250 lb original tension + 156 lb tension due to temperature change = 406 lb tension/strand

Note: This force is well below the wire breaking strength so there are no concerns about wire damage.

- **Change in Brace Forces**

Wire force on end braces from fence wires when built:

5 strands x 250 lb per strand = 1,250 lb force (original)

Increased force from fence wires due to temperature change:

= 5 strands x 156 lb added tension per strand = 780 lb force (total added)

Total force at -30°C = 1,250 lb (original) + 780 lb (added) = **2,030 lb brace force**

Note: This example is for five single strands of 12½ ga wire. If five two-strand wires were used (i.e. two strand barbed wire), each wire strand adds 156 lb tension to the braces. Each wire would have a tension of 562 lb (250 + 156 + 156) and the total brace force would be 2,810 lb (1250 + 780 + 780).

SUMMARY OF STEEL FENCE WIRE REQUIREMENTS

A thin steel fence wire is preferred rather than a thick wire because it has greater elasticity and is less affected by temperature changes. However for the same grade of steel, the thinner wire would have a lower strength. To overcome this, a thin wire of high tensile strength steel may be chosen. This is why fence builders are moving towards using 12½ ga high tensile steel wire. A single strand of high tensile wire will out perform two strand low tensile wire and do it at a reduced cost.

However, as shown in Table 1, strength and elasticity advantages come with some disadvantages. In the end, fence wire decisions are made considering all the factors.

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Fencing FACTSHEET



Order No. 307.100-2
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FENCE WIRE

Dispensing, Stapling, Joining, Tying, Tensioning, and Grounding

This Factsheet outlines handling information for barbed wire, high tensile smooth wire (htsw) and woven wire.

DISPENSING WIRE

Fence wire must be dispensed or played out in a uniform manner that does not damage the wire or its galvanized coating. Wire can either be pulled off a stationery roll or the wire tied to an end post and unrolled along the fence line. The choice depends on the packaging of the wire (loose roll or drum roll), the type of wire and the equipment available.

Dispensing Barbed Wire

Standard barbed wire is sold in rolls on a wire drum. The wire should be rolled off this drum in the same manner it was packaged, by rotating the drum. Do not loop the wire off the side of the drum as it may kink and weaken.

By inserting a rod through the drum, it can be mounted (on a tractor 3 point hitch or pickup truck box) to rotate as the wire is pulled off. Alternatively, two people can carry the rod/drum along the fence line unrolling wire as they proceed. Due to the nature of barbed wire, it tangles very easily. Each strand should be installed on the posts before the next one is played out.

Dispensing HTSW

High tensile smooth fencing wire has been available in two types of packages, loose roll and drum roll. As with barbed wire this wire must be dispensed by rotating the roll not by pulling loops off the side of the roll. This is very important with htsw as it is subject to breakage if kinked.

The loose roll package is not commonly produced because it is less convenient to dispense than the drum roll. Whereas the drum roll only requires a rod inserted through the drum to dispense, the loose roll required a special tool called a "spinning jenny". The drum roll package is now standard in B.C. As with barbed wire, the drum roll can be either set stationary or rolled out along the fence. However, because htsw has no barbs it does not tangle as readily and more than one strand can be dispensed at one time. By dispensing all wires in one pass along the fence line considerable construction time is saved. Refer to Factsheet 307.600-1 *Wire Fence Construction*.

Dispensing Woven Wire

A standard woven wire roll is 330 feet that may weigh from 150 to 400 lb and is not carried by hand. The roll can either be laid on the ground and rolled out (terrain and vegetation permitting) or mounted horizontally or vertically on a tractor for dispensing. Farm-made devices that mount on a tractor 3 point hitch work well. Two rolls (660 ft) should be the maximum length dispensed per fence section to allow for proper tensioning. Longer sections are difficult to handle and tension correctly.

Special Equipment

Wire unrollers and retrieval equipment may be used to aid in construction and recovery of any type of fence wire. Units are available that are tractor mounted and powered or that are truck mounted and electrically powered. Capacities of 500 feet of fence wire per minute are advertised.

STAPLING WIRE

Attaching the fence wire to posts is an important aspect in fence construction. How the wire is stapled onto posts may determine the success of the fence.

Types of Staples

The common fence staple is slash pointed (the point is not centered like a nail point) so it will provide pullout resistance as it enters the post (see discussion below). Where greater resistance is required, a “barbed” staple is available which has a small cut in each leg forming a projecting barb. This barb acts like a fishhook; it will easily enter the post but grips the post if pulled out.

The table below gives the number per pound and per box of standard fence staples.

Fence Staples: Numbers per Pound and per Box

Staple Size (9 ga)	Number per Pound	Approx. Number per 50-lb Box
1½ in	72	3600
1¾ in	61	3050
2 in	58	2900

Stapling Wire. Except when stapling at tie off points, **fence wire should always be stapled loose** as shown in Figure 1, below. To allow for the reduced staple length that can be driven into the post, use a minimum staple size of 9 ga x 1-3/4 in. (preferably 2 in.). Staple cost per mile of fence is very low even when using these larger sizes. Choose hot-dip galvanized (rough surface) over bright, ungalvanized staples for extra life and pull out resistance. By stapling the wire loosely, lateral movement of the wire is permitted. This spreads fence loads over a greater length of wire. In barbed wire fences, stapling loose is preferred but it may have only limited benefit, as the barbs will catch on the staples at some posts. Woven wire fences have limited movement due to the nature of the fabric.

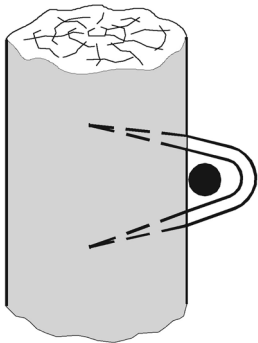


Figure 1 Loose Stapling of Fence Wire

In htsw fences, the wire is free to move from end brace to end brace, transferring fence loads from the entire fence section to the end braces. This allows the elasticity of up to 1320 feet of htsw (versus 30 or 40 feet of barbed wire) to absorb windfall trees, livestock pressure, etc. Note that because of this load transfer, htsw fences require good end brace construction - refer to Factsheets 307.220-1 *Brace Assemblies for Wire Fences - What They Are, How They Work, How to Construct Them* and 307.220-2 *Brace Assemblies for Wire Fences – End, Inline and Change of Direction Braces*.

Wires should be held against the post by the worker when stapling. The staple should not be used to pull the wire to the post. Hitting the wire with the hammer during “misses” will chip off the zinc coating and shorten the wire life.

Positioning Staples

How a staple is positioned on the post before being driven in is a small but important detail often overlooked. Anyone who has a tin of used staples recovered from an old fence will have seen that some staples have their “legs” crossed while others have their “legs” spread open. It’s obvious the staple that spreads out into the post has greater pull out resistance than the one that crosses over on itself (tests indicate 40% increase). How can you ensure this spreading occurs?

Staples are formed with off-centre pointed ends called slash-cut points. Whereas a center pointed nail can be driven straight, slash-cut staples are **expected** to curve as they enter the post, and they **always** curve away from the slash-cut or flat face.

It is well known that a staple should not be driven in parallel to the wood grain (to avoid splitting) but should be turned slightly. Because of the curving nature of the staple legs as they enter the post, **always turn the staple away from the slash-cut** to ensure the staple legs will spread apart providing maximum pullout resistance. Because all staples in a box are made the same this soon becomes second nature. In fact, most staples seem to be made with the same slash point and will be turned slightly clockwise as shown in Figure 2, below.

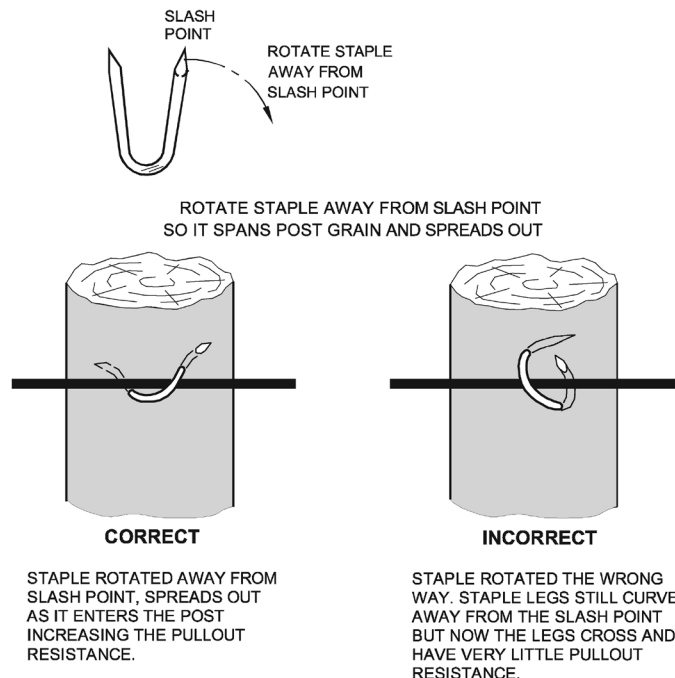


Figure 2 Positioning Staples for Maximum Pullout Resistance

Special Stapling Situations

Whenever the fence wire changes direction at a post (rise, dip or corners) special stapling methods are used. The following points are illustrated in Figure 3, below:

- At rise posts - there is downward wire pressure; angle the staple downward into the post; double staple on steep rises.
- At dip posts - there is upward wire pressure; angle the staple upward into the post; double staple on steep dips.
- At shallow corner posts - there is some friction between post and wire; use a single staple with one slider staple.
- At sharp corner posts; there is significant friction between post and wire; use two staples with two slider staples.

Note that there is a “non-staple” option for htsw fences that are short or those with high pressure on both sides - the line posts may be drilled and the wire threaded through without any stapling required.

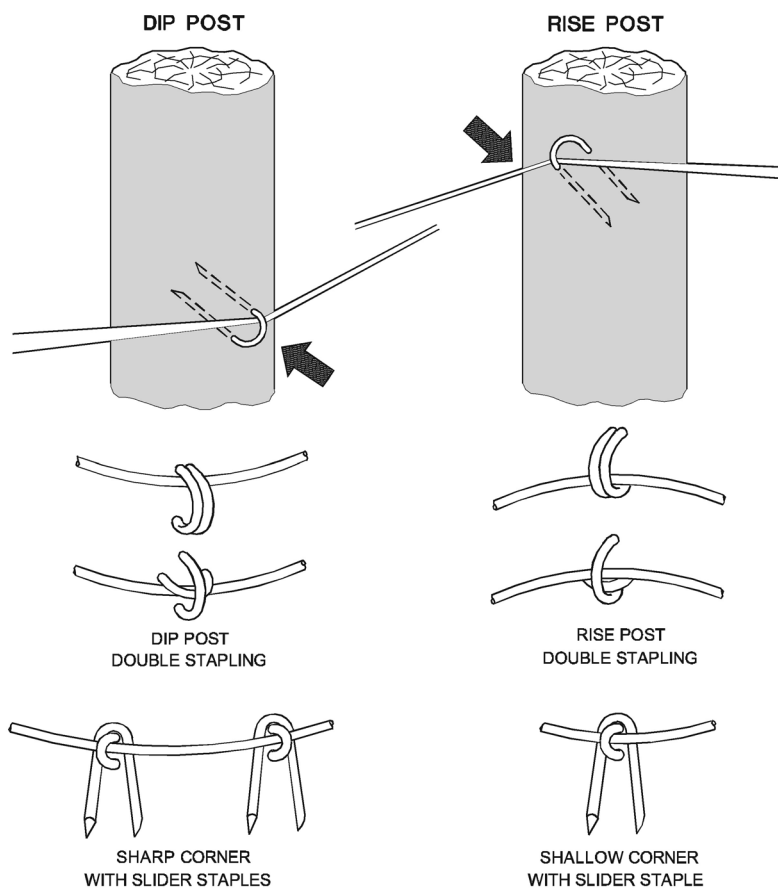


Figure 3 Special Stapling Methods

JOINING AND TYING WIRE

Wire connecting and tying off wire at the end of runs is done using methods dependent on the type of wire. The main differences are between soft, low tensile wire and the more brittle, high tensile wire.

Whenever a knot is used in any wire, the breaking strength of the wire is reduced, or put more simply, **no knot is as strong as the wire it joins**. Only some mechanical splices offer 100% of wire strength.

Tie-Off Rule

The distance between tie-off points for wire fences varies by the type of wire:

Barbed wire - 660 feet - limited due to the barbs catching on posts.

High tensile smooth wire - 1320 feet - longer than other wires due to its elasticity.

Woven wire - 660 feet - limited due to handling difficulties on longer lengths.

Barbed Wire - Joining and Tying Off

The low tensile wire most commonly used in barbed wire can tolerate joints and tie offs made by knotting the wire. These do not vary sufficiently to justify a recommendation for a particular knot. Ease of tying becomes the deciding factor. The knots in Figure 4, below, are commonly used to join and tie off barbed wire and are effective to approximately 80% of the breaking strength of the wire. The “Gripple” mechanical splice (bottom photo) provides 100% of wire strength. Note that the barbed wire cannot pass through the Gripple.



Figure 4 Knots and Mechanical Splice for Barbed Wire

HTSW - Joining and Tying Off with Knots

Knots are not generally recommended for the brittle high tensile wire. However, the wire can be tied off using an end post knot (for 1100 lb or 80% of wire strength) and joined using the figure 8 knot (for 1200 lb or 89% of wire strength) as shown in Figure 5, below. Because of this loss of wire strength and the difficulty in knotting htsw, mechanical splices are generally recommended.

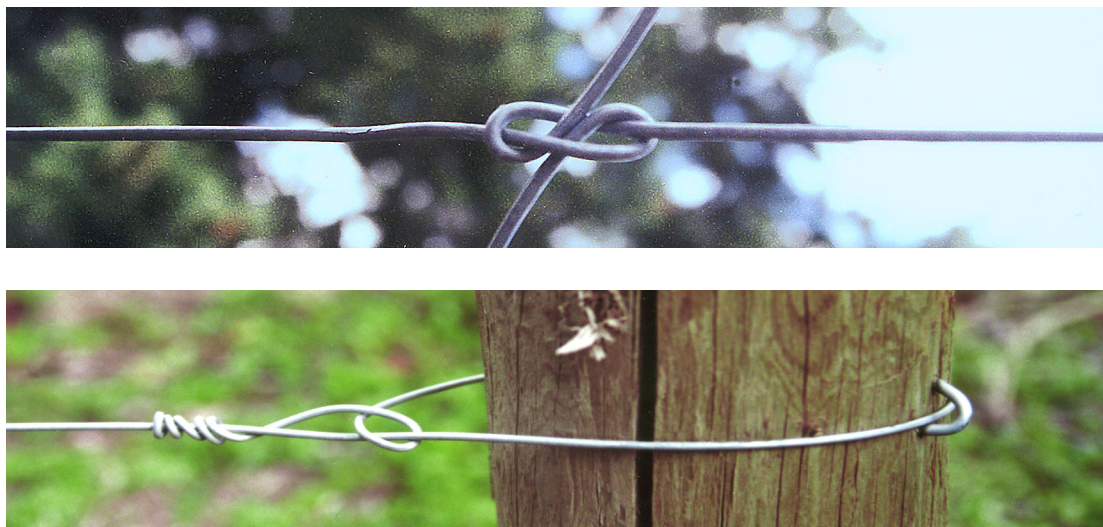


Figure 5 Knots for High Tensile Smooth Wire

HTSW - Joining and Tying Off With Mechanical Splices

To maximize the benefits of this stronger wire, several mechanical splices are available that produce a connection with 100% of the wire strength. Use a splice that is specifically designed for high tensile galvanized steel fence wire. Four commonly used, commercially available splices are shown in Figure 6, page 7. These mechanical splices all cost more than knots (and some require special tools) but have the advantages of full wire strength, ease of installation and most leave no long “stray” wire ends as do knots. Two types also can be used as wire tensioners.

Nicopress. This is a sleeve that slides on to the two wire ends and is compressed with a special tool. Two sleeves are required for a tie off and three for an inline splice. Use sleeve #FW-2-3 for 12 1/2 gauge high tensile fence wire.

Wirevice/Wirelink. This is a device with spring loaded tapered jaws that allow the wire to slide in one direction but grip it when pulled in the opposite direction. Wirelink has two sets of jaws and is used for an inline splice. Wirevice has one set of jaws and is set in the end post for tie offs. It can be used to tension the wire.

Gripple. Similar to Wirelink but reusable as the wire can pass through the jaws. A special tool allows wire tensioning through the Gripple. A model is available for barbed wire; see Figure 4.

Vineline. This is a one foot long spiral wire that is twisted onto the fence wire. It has a gritty inner surface. One vineline splice is used for a tie off, two (one wrapped over the other) are used for an inline splice, as shown in bottom photo of Figure 6.

Nicopress



Wirelink



Gripple



**Vineline
(partially installed)**



Wirevice



Figure 6 Mechanical Splices for High Tensile Smooth Wire

Woven Wire - Joining and Tying Off

Woven wire is manufactured using both low and high tensile wire so connections can be made using the previously discussed knots and splices. The two commonly used methods are shown in Figure 7, below. If possible the twist-wrap joint should be made where the two verticals meet. End post tie offs will require the removal of several of the last vertical wires (to provide sufficient tie wire) then knotted as in Figure 5, page 6.

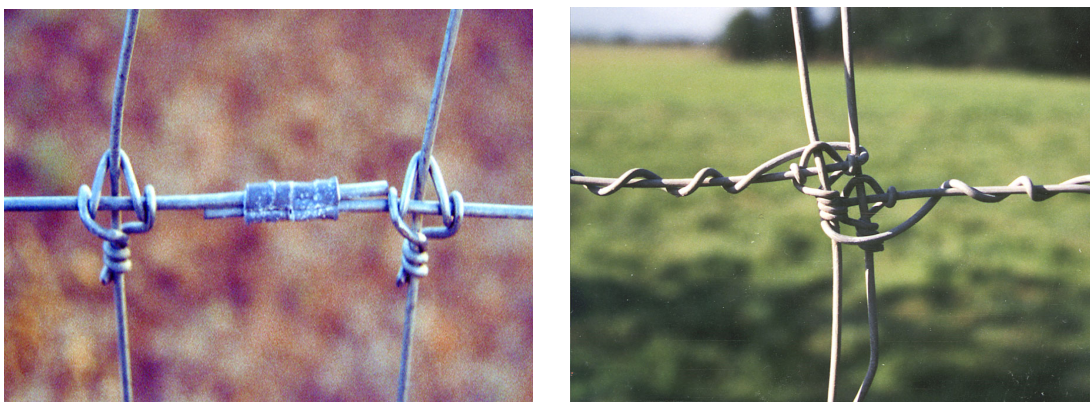


Figure 7 Woven Wire Connections: Nicopress sleeves (left) and Twist Wrap Knot (right)

TENSIONING WIRES

There are numerous tools available for stretching or tightening fence wire. Some common ones are the corner-post, in-the-crank, walk-along, tree-and-post, gripchain-walking and rope-and-pulley stretcher. Approximately the same tension (250 lb) is required for all nonelectric wire fences. The tension used on electric fence wires is one-half of this (125 lb) or just more than “hand tight.”

If tensioning is done when the air temperature is approximately half way between the maximum and minimum encountered, it will reduce the effects that temperature variation has on wire tension. But as discussed in Factsheet 307.100-1 ***Commonly Used Wire for Agricultural Fences***, the increased tension due to temperature changes is not a major concern.

Tensioning Barbed Wire

New, two strand barbed wire requires pretensioning (refer to Factsheet 307.100-1 ***Commonly Used Wire for Agricultural Fences***). It should be stretched up to an initial 600 lb to pull the two strands tightly together and to “set” the barbs between the line wires. The wire is then relaxed to approximately 250 lb of tension. As barbs have a tendency to “hang up” on the staples, it is important that barbed wire be tensioned before it is stapled to the posts.

Tensioning H T S W

This wire is tensioned to 250 lb; tension levels above this are difficult to maintain and serve no useful purpose. Permanent inline wire tensioners are available to tension the wire. They remain on the fence wire and are available for future maintenance tensioning.

Permanent wire tensioners should be placed in the middle of the strain for maximum benefit. For level terrain this would be the center of the fence section. In fence sections where several corners or dips and rises occur (more resistance to wire movement) the tensioners should be closer to the resistance points.

There are several inline tensioners available, divided into two basic designs. Both types use removable handles to operate the tensioner and have pins to secure the tensioner from unwinding. One type requires the wire to be cut and the tensioner is spliced in; refer to Figure 8, below. The disadvantage of the splice-in type is the extra effort required to make the attachment to the fence wire. Also, there is a tendency to place this type of tensioner at the end of a fence section (at the tie off post) which is not usually the preferred location (i.e., which is near the middle of the strain).



Figure 8 Splice-In Tensioner for High Tensile Smooth Wire

The second type is placed over the wire (the fence wire is not cut). Drum or half drum designs have a slot to allow easy attachment at any place along the fence wire; refer to Figure 9, below. Note also that two types of splices (Wirevice and Gripple) may be used for tensioning htsw (refer to Figure 6, page 7).

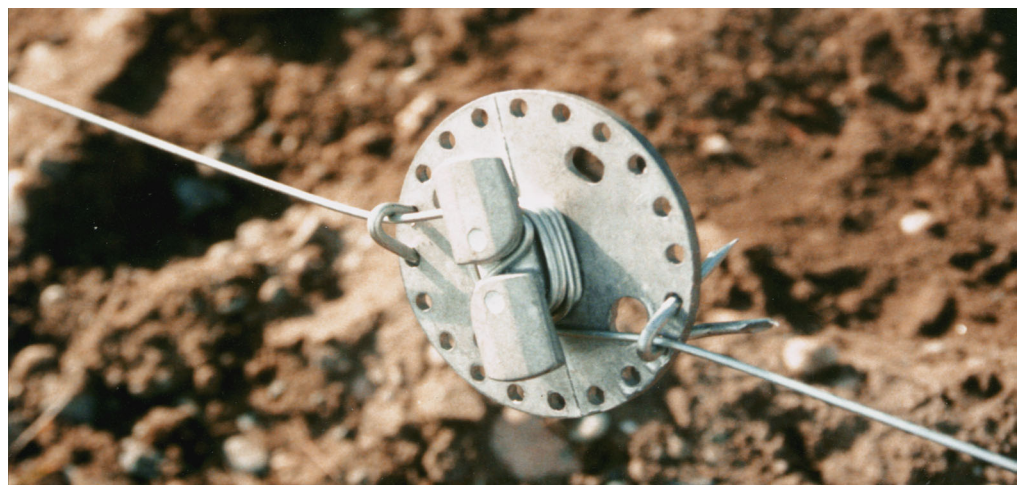


Figure 9 Slotted Drum Tensioner for High Tensile Smooth Wire

Tensioning Woven Wire

The horizontal strands of woven wire are produced with waves or “tension curves” every six inches or so. When woven wire is tensioned, up to one-half of this curve is removed, leaving enough “tension curve” to allow the wire to absorb fence loads. Refer to Figure 10, below.

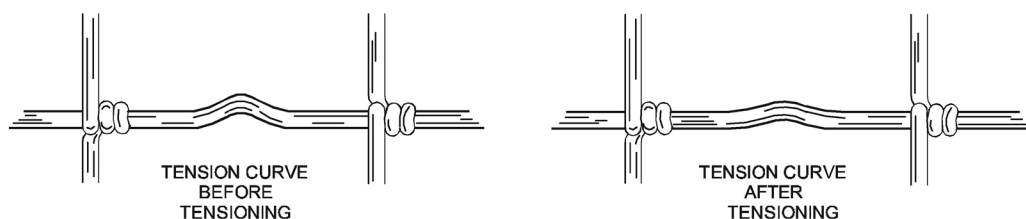


Figure 10 Tension Curve in Woven Wire

Woven wire is tensioned in the upright position. Figure 11, below, illustrates how this wire can be tensioned from one end. To apply tension equally to all line wires, a straining clamp must be used. A typical homemade clamp consists of two hardwood boards (which contact the woven wire) and steel reinforcing to withstand the tensioning load. The straining clamp is pulled using a come-a-long that is suitably anchored, i.e. to a tractor or truck. While a very low “crawl” gear tractor can be used instead of the come-a-long, it is not recommended due to the possibility of over tensioning the wire and the danger to the operator should the wire break.

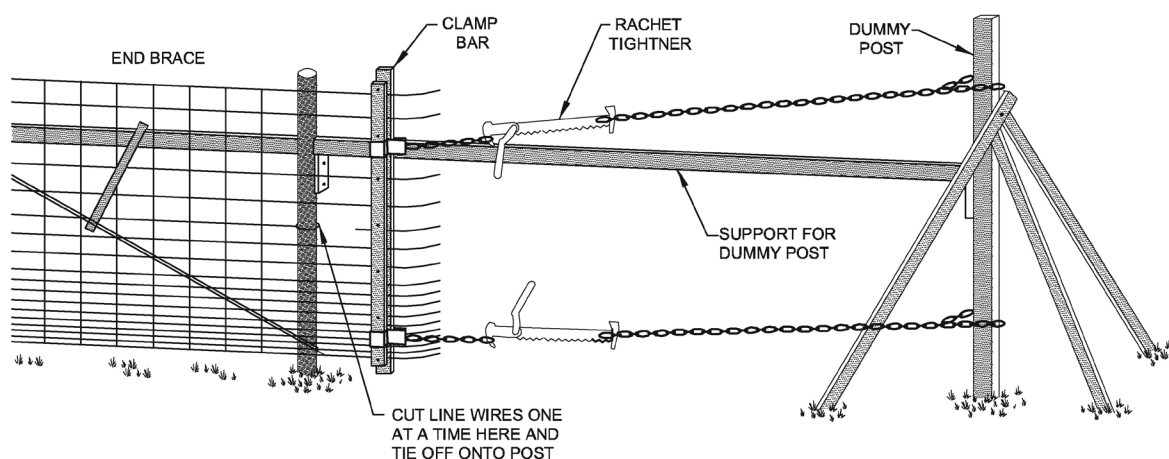


Figure 11 Tensioning Woven Wire from One End

An alternate method is sometimes preferred on long fence sections (greater than one roll - 330 ft) to more easily obtain consistent wire tension. The wires are tied off at each end brace and two straining clamps are used and pulled together as shown in Figure 12, page 11. The distance between the clamps prior to tensioning is determined by the total length of fence, allowing approximately 1 ft per 65 ft of fence. For example, if two rolls (660 ft) are being tensioned, the clamps should be just over 10 feet apart. The joint may be made using either a mechanical splice or knot as shown in Figure 7, page 8.

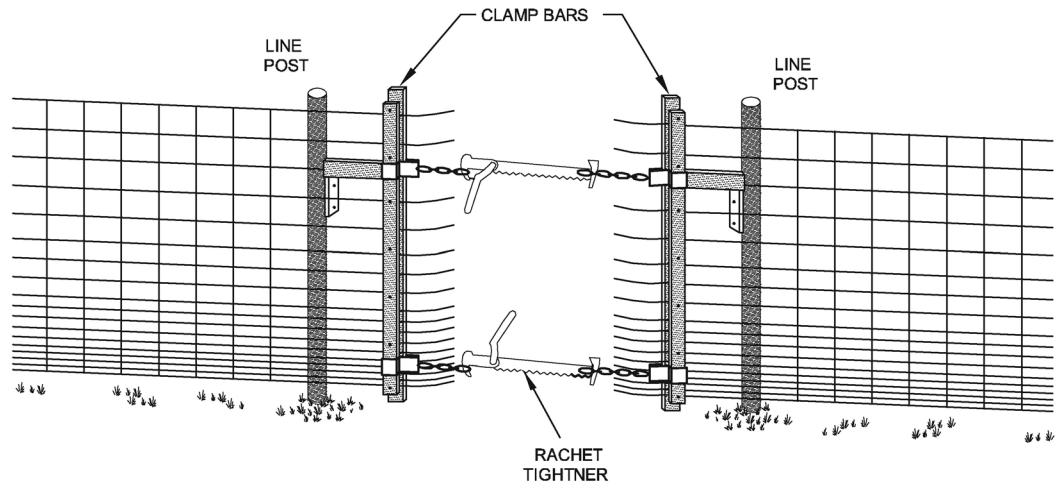


Figure 12 Tensioning Woven Wire from Two Ends

Measuring Wire Tension

Individual fence line wire tension can be measured using a simple homemade device constructed as shown in Figure 13, below. On a board 42 inches long, drive two nails 40 inches apart (nails 1 and 2) along a center line. The third nail, in the center, should be one half inch below the centre line. Using a small spring scale (while touching the wire with nails 1 and 2) pull the wire until it just touches nail 3. Read the scale and multiply by 20 to get the approximate wire tension. For example, if the scale reads 12.5 lb, then the wire is properly tensioned to 250 lb.

An alternate method is to use inline tension indicator springs. A spring is wired into a fence line wire and the compression of the spring is measured as the fence wire is tensioned. Typical springs that are used compress at the rate of one inch per 150 pound load. Therefore a compression of 1 1/2 to 1 3/4 inches approximates a 250 pound fence wire tension. This method is not commonly used.

These springs are left on the fence and have a secondary use as they provide additional elasticity or “give” to the fence wire when loads are applied. The cost and added complexity may not justify either the tensioning or elasticity benefits.

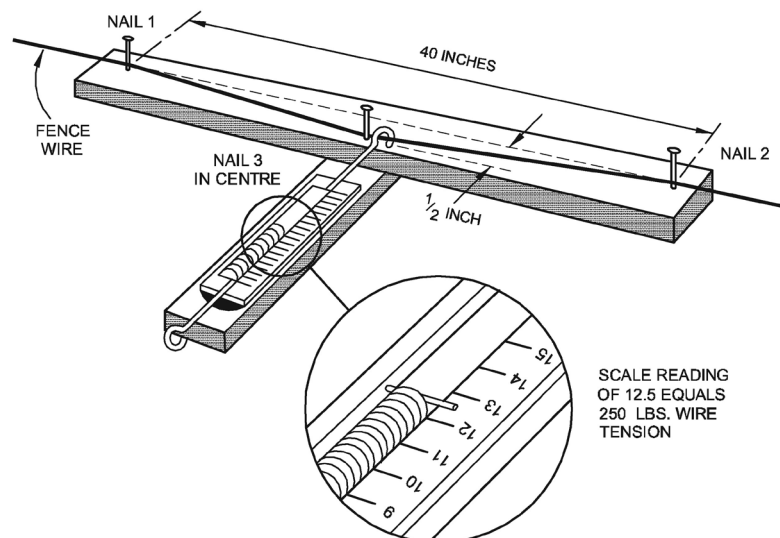


Figure 13 Wire Tension Measuring Device

GROUNDING NONELECTRIC FENCE WIRES

Steel fence wires on nonconductive (i.e., wooden) posts can act as conductors of electrical currents from lightning, fallen overhead utility wires or other sources. To protect humans and livestock from accidental electrocution, these fences should be grounded. Usually this is only done in high-risk areas.

Presently, there is no Canadian or Provincial code which specifies this requirement and at which interval; however, it is probably advisable to go with 660 feet spacings in wet climatic regions and 330 feet in dry regions.

For proper grounding, a 6 foot long, 5/8 inch diameter galvanized steel rod is driven into the ground. A ground rod clamp is attached to the rod. Five strands of wire (approximately 6 feet long) are attached to the clamp and the wires are woven and twisted through all line wires forming the cable so that all line wires and grounding wires touch. After lacing in the uppermost wire, the five wires are twisted together and securely stapled to a line post as shown in Figure 14, below.

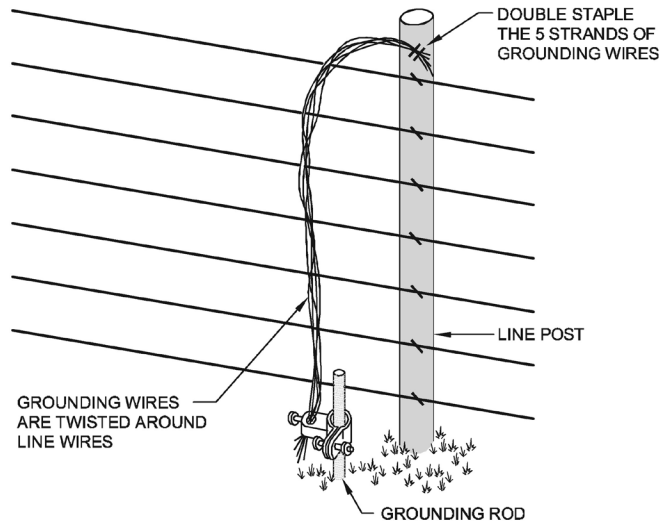


Figure 14 **Grounding Nonelectric Fence Wires**

Grounding Along Powerlines

For fences that run parallel to, or cross under, overhead powerlines, precautions must be taken to properly ground the fence. The following information is from BC Hydro (check with them regarding the size of powerline). Fences require grounding stations at intervals indicated under the following conditions:

- Fences on the Hydro right-of-way:
 - 200 ft or more of fence and a 500,000 volt line
 - 400 ft or more of fence and a 360,000 or 230,000 volt line
- Fences parallel to and within 250ft of the outside Hydro conductor:
 - 1000 ft or more of fence and a 500,000 volt line
 - 2000 ft or more of fence and a 360,000 or 230,000 volt line

If a fence requires grounding, both sides of every gate or other break in the fence should also be grounded. Contact BC Hydro regarding these situations and they will assist, perhaps actually doing the grounding.

An electric fence cannot be directly grounded but there are special filters that are attached to remove any current developed due to the fence location near a high voltage line. The electric fence still functions normally. Electric fences require filters when:

- Fences cross or are located on the BC Hydro right-of-way:
 - 100 ft or more of fence
- Fences are located parallel to and within 250 ft of the Hydro outside conductor:
 - 500 ft or more of fence

Possible Effects from Lightning

Careful observations in Oklahoma on barbed wire fences from 1941 to 1963 indicates possible loss of wire galvanization due to lightning on ungrounded fences. Fences where a “twist-wire” type of fence dropper had been used (and had good ground contact) had wires in good condition after over twenty years. Most other fences had losses of galvanization, ranging from severe on the top wires to minimal on the bottom wires.

Although conditions may vary in B.C., it could be a worthwhile recommendation to consider thorough fence wire grounding in areas known to experience lightning. It may be that the metal style droppers (twist-wire or sheet metal), with good ground contact, could perform this function when placed in each fence panel. In areas expected to receive limited or no lightning, the standard grounding practices discussed above will be sufficient.

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DROPPERS FOR WIRE FENCES

This Factsheet looks at the options for droppers for high tensile smooth wire and barbed wire fences.

GENERAL REQUIREMENTS

After fence wires have been strung and tensioned, it is apparent that between fence posts the wires could be spread open and livestock pass through. The wider the post spacing, the easier it is to spread the fence wires. To prevent this and make the fence secure, fence line posts could be spaced very close together. However, to reduce material and installation costs, and to maintain fence flexibility and integrity, battens can be installed between the posts. These battens are called stays or droppers and are used on all types of wire strand fences, electric and nonelectric.

Functions The functions of a fence dropper are:

- to maintain fence wire spacing between posts
- to add fence visibility between posts

Good fence droppers must perform these two functions and should also:

- be strong enough to resist breaking under livestock pressure
- be able to be securely fastened to the fence wires
- not damage the fence wire
- be able to be installed at low cost (i.e., quickly and easily)
- be available at a low purchase cost

Many droppers are also easily adapted to fences of varying wire numbers and spacings rather than being made for one specific fence design.

Installation Droppers are installed after the fence wires have been fully tensioned. They should be installed so they do not touch the ground to maintain the fence flexibility and upright position of the dropper. Dropper spacing will vary depending on the livestock pressure on the fence, but for most fences the spacing will be no greater than ten feet. Spacings as close as five feet may be used on pen or feedlot fences. See Factsheet 307.260-1 *Livestock Control – Non-Electric Fence Designs* and 307.260-2 *Livestock control – Electric Fence Designs* for fence designs with dropper spacings..

Types of Materials Most droppers are made of either wood or metal, but other materials such as plastic rods or pipe are used.

The following illustrates commonly used dropper designs on barbed and high tensile smooth wire fences.

WOODEN DROPPERS

Wood is the most commonly used material as it is plentiful, low cost, easily worked, durable and provides good visibility when properly sized.

Wooden Droppers for Barbed Wire

The majority of barbed wire fences use wooden droppers, sometimes simply tree branches, etc. available along the fence right-of-way. Because of the surface texture of barbed wire (two twisted strands of wire with frequent barbs) droppers can be simply wire tied (tightly). They seldom slide under livestock pressure when properly tied as shown in the photo at right. Low tensile (soft) wire is used for the tie wire as it is easy to knot. This wire should be galvanized for long life.



**Wooden Dropper
on Barbed Wire**

Wooden Droppers for Smooth Wire

Securely attaching droppers to smooth wire is more difficult than to barbed wire. Wooden designs all have a slot, notch, hole or other method of gripping the fence wire. In addition they may also be wire tied on. Simply tying on a stick, as can be done for barbed wire, is generally not sufficient. However the first design shown below has proved effective.

The following six designs are used on smooth wire. Where required, use a tie wire of low tensile (soft) galvanized wire.

Wire-Tied Cedar While normal or casual tying of wooden droppers to smooth wire is ineffective, this method has been proven to work. Cedar, being soft, is “imprinted” by the wire when tied tightly. Cedar also tends to have little shrinkage as it dries, so the dropper will not loosen. Use cedar with a cross section slightly larger than for other (stronger) wood.



**Wire-tied Wooden
Dropper on HTSW**

Wooden Droppers for Smooth Wire

(continued)

Angled Slots (all on same side) A dropper of 1 1/2 in. by 1 1/2 in. material has slots cut 10 degrees off horizontal, 1/8 in wide (saw blade width) by 5/16 in. deep. All the slots are on the same side of the dropper (wire tension is not affected by dropper installation). It grips the fence wire due to the angle of the slot. This design, while effective, may be prone to failure if livestock pressure is great enough to force the wire out of the slot. The slots can be cut all in the same direction or the slot angle can be cut in an alternating angle pattern (as shown) for increased retention to the fence wires.



Angled Slot Dropper on HTSW

Angled Slots (on opposite sides) The same material and slot size as the previous dropper but the slots are on opposite sides. This requires the dropper to be woven into the fence wires which improves dropper attachment under livestock pressure. However it also increases wire tension as the “path” of the fence wire is slightly increased. The slots may or may not be cut in alternate directions as the previous dropper. Each dropper may be woven into the fence wires in the same manner or in an alternating manner. Wire tension is greatest when the alternation weave is used.



Angled Slot Dropper on HTSW

Horizontal Slots / Wire-Tied The same material size is used as the previous droppers but with horizontal slots that are cut shallower (3/16 in.). This design uses the slot to locate the fence wire on the dropper but is wire tied for security. This adds to the installation time (costs). Multiple slots can be cut so the dropper can be attached to various fence designs (various numbers of wires and wire spacings).

Note that when these slotted wooden droppers are used on moderate or heavy livestock pressure fences they require relatively defect-free hardwood as the slots weaken the dropper. Lower grade woods will require larger cross sectional sizes. Also note that the angled slot designs are made for a specific fence design (number of wires and wire spacings).

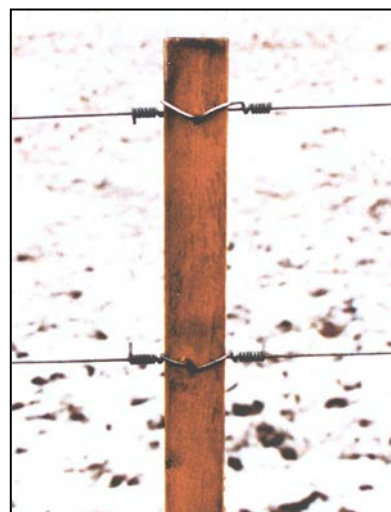


Horizontal Slot Dropper on HTSW

Wooden Droppers for Smooth Wire

(continued)

Drilled Hole / Wire-Tied A 1 in. by 3 in. board has 3/8 in. holes drilled that match the number and spacing of each fence wire. A 12 in. piece of “soft” wire (approximately 12 ½ ga) is bent in half (like a long staple). The dropper is attached to each fence wire with one “staple” that is placed over the fence wire, through the dropper hole and the “staple” ends bent back and twisted onto the fence wire. This provides a secure dropper and the dropper size offers good visibility and strength. Installation time is similar to the horizontal slot/wire tied design. They can be readily made on farm of rough sawn boards that are gang-drilled to suit the number and spacing of fence wires.



Drilled Dropper on HTSW

Stapled On Any of the previous material sizes can be stapled on instead of slotting or wire tying on. This, however, requires seasoned wood (green wood will dry, shrink, and become loose) and usually more effort. If the staple angle is alternated for each fence wire (turned to the left and then to the right - contrary to standard stapling theory) more wire gripping can be achieved. Also the vertical alignment of the staples should be staggered so as to prevent the dropper from rotating under pressure. The staples (use barbed staples?) must be driven “home”. These can be low cost droppers but good attachment is not always possible.



Staple on Dropper on HTSW

METAL DROPPERS

Metal Droppers for Barbed Wire

This material is used in either a wire or sheet metal form (usually galvanized steel). Strength and visibility vary compared to wood as discussed below.

Twist on wire droppers are used on fences because of the ease of installation and because they are universally adapted to fences (they are made to suit any fence). However they do not have two important dropper requirements; they lack strength (they deform under low livestock pressure and stay deformed) and have low visibility. They are generally not recommended except for low-pressure fences.

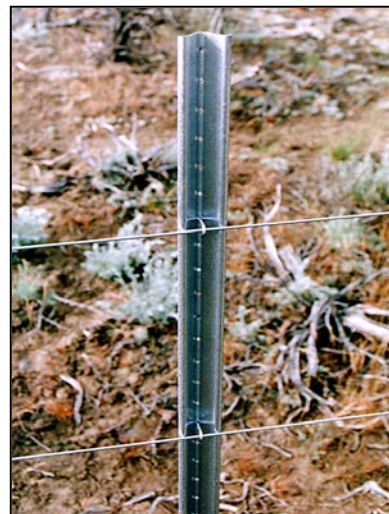


Metal Dropper on Barbed Wire

Metal Droppers for Smooth Wire

Twist on wire droppers are also not suitable for smooth wire fences because of low strength, poor visibility and they are easily moved sideways on smooth wire by livestock. However, a formed sheet metal design is used.

Vee-Shaped / Clip-On A notched sheet metal dropper was once available but they were weak and scraped the wire galvanizing. Currently, a vee-shaped cross section dropper (with rolled edges where it contacts the fence wire) is used that is adequate. A nail is inserted through a hole in the vee and bent over the fence wire to secure the dropper onto each fence wire (one nail per fence wire). Multiple holes make the dropper adaptable to any fence design. Some dropper bending may occur under moderate to high livestock pressure. Dropper purchase cost may limit its use, however, it is generally quick to install and has good visibility.



Metal Dropper on HTSW

OTHER DROPPER MATERIALS

Most wood and all metal droppers are not suitable for use on electric fences. Although many electric fences use no droppers, when they are used they must be nonconducting (unless all fence wires are electrified). Fibreglass or plastic materials are therefore often chosen. As little contact is expected by livestock on an electric fence, attachment of droppers is not as great a concern as on nonelectric fences.

Pultrusion Rod

This material is a fibre reinforced plastic formed by pulling through a mold (pultruded). Various colors and sizes are available for good visibility and strength. The material will weather well and will not be affected by water. They are tied onto the fence wires.

Polyethylene Pipe

Small diameter polyethylene pipe can be slotted and wire pinned between two strands of electric fence wire to act as a low cost dropper.

FOR FURTHER INFORMATION CONTACT

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MINISTRY OF AGRICULTURE

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FENCE POSTS

Materials, Installation and Removal

Fence posts are principally used to support and space the fence wire to contain or direct animal movement. They must be strong enough to resist pressures exerted on the wires. Furthermore, posts must have a long life expectancy by resisting decay, rotting or rusting. They must be relatively easy to install and to attach wires to, and they must do all of this at a reasonable cost.

WOODEN POSTS

The most suitable and most used material for agricultural fence posts is wood; specifically round, chemically pressure treated softwood, such as Lodgepole Pine. The principal reasons for this preference are that wooden posts are in good supply in B.C.; they have a high strength to relatively low weight ratio; are economical and provide a long service life. As well, they can be driven into the soil with power equipment and the fence wire can be easily stapled to wooden posts.

Wooden Post Strength

Experience in fence construction is used when selecting wooden post materials and sizes for various fence requirements. Line posts, brace posts, etc. are sized for the load they are expected to resist. Figure 1, below, indicates the approximate breaking strength of pressure treated pine posts, the most commonly used in B.C.

Split cedar is also used for fence posts (especially in coastal areas where the wood is common). It may be selected for organic farms as it can be used untreated. Table 1, page 2, indicates expected life for untreated first growth cedar. Choose a split post with a triangular cross section that could contain the round post size recommended for the required use.

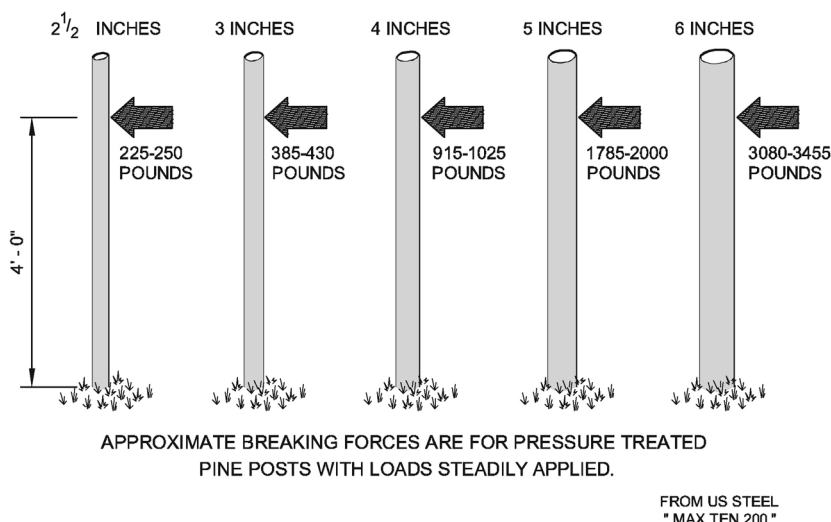


Figure 1 Pine Fence Post Strength

Wood Decay

The biggest disadvantage in using wood as fence posts is the fact fungi attack and decay wood to the point where the post no longer has the required strength (see Table 1, below). However, fungi can only grow and cause decay if the correct conditions of moisture, air supply, temperature and most importantly, food supply, exist. Various treatments are available to greatly reduce fungal growth and extend fence post life.

Wood maintained at 20 percent moisture or less will not decay nor will wood deep in the ground where oxygen is very low. However, optimum conditions for fungal growth occur in a zone approximately one foot above and below ground level. This is also the area where maximum fence post strength is required. As shown in Table 1, below, only cedar should be considered for use untreated for fence posts.

Table 1 LIFE EXPECTANCY OF UNTREATED WOODEN POSTS (HEARTWOOD)	
Wood	Untreated Life (years)
Cedar (1 st growth)	20 - 30
Tamarak	10 - 15
White Pine	8 - 12
Douglas Fir	7 - 12
Birch	5 - 10
Willow	5 - 8
Ponderosa Pine	4 - 14
Lodgepole Pine	4 - 12
Spruce	4 - 6
Poplar	3 - 5

From: USDA and Alberta Agriculture

Wood Treatments

An “old time” wood treatment method involves the use of fire to char the surface of the wood that will be in ground contact. While slow it was an inexpensive treatment when used for a few poles, for instance in barn construction. It would not be practical to consider this method for the number of posts required for fencing.

Most all other treatments involve the use of chemicals that make the wood toxic to fungi, removing it as a food source. There are two distinct application methods:

- **Soaking Treatment** - a suitable on-farm method
- **Pressure Treatment** - commercially applied in a pressure tank

Treatment is rated by the amount of chemical absorbed into the wood. The depth of penetration is not necessarily an indicator of the quality of treatment. **Pressure treatment is by far the most effective method of applying wood preservative chemicals.** Only when on-farm posts are available at little or no cost should a soaking method be considered. Even then it may be better to have them pressure treated. Refer to publication 378.600-3 *Wood Preservation on the Farm*.

Treatment Chemicals

While there are a wide variety of wood preservatives used for fence posts, they fall into two distinct categories. Those marked ¹ are chemicals used by pressure treatment plants. Only CCA is now commonly used.

Oil-borne Preservatives

These are not water soluble:

- **creosote¹** - effective, low cost, noncorrosive to metals; strong odor, oily, irritating to the skin, can leach out of the post
- **pentachlorophenol¹** - penta or PCP; environmental concerns limit use
- **copper naphthenate** - green cuprinol
- **zinc naphthenat** - clear cuprinol

Water-borne Preservatives

These are water soluble:

- **chromated copper arsenate¹** - CCA; does not leach out once dried in the post
- **ammoniacal copper arsemate** - ACA; does not leach out once dried in the post
- **copper sulfate** - Bluestone; will leach out of post reducing effectiveness

Other materials, such as coal tar, crude petroleum, fuel oil and diesel, when used alone, have very little preservative value.

Safety Concern

Posts treated with any of the preservatives and then dried before use are unlikely to cause more than minor skin irritation when handled. Nevertheless, it is advisable to use gloves when handling treated wood, particularly if it was treated with oil-borne preservatives such as creosote or pentachlorophenol.

Wooden Post Sizes

Wooden posts are sized by the diameter range (inches) x length (feet):

- 2 to 3 inch x 6 to 8 feet (electric fence line posts)
- 3 to 4 inch x 6 to 10 feet (standard livestock fence line posts)
- 4 to 5 inch x 8 to 10 feet (standard braces or game fence line posts)
- 5 to 6 inch x 8 to 11 feet (game fence braces)

Posts are normally peeled, pointed and domed before pressure treatment. Domed posts have the “corner” removed from the top end to reduce splintering from the post driving impact.

OTHER POST MATERIALS

Although wood is the most common material for agriculture fence posts, three other materials are used as well; steel, concrete and standing trees. Special posts used in electric fencing are discussed on page 5.

Steel

Steel posts are formed into a T, U or Y cross section and are either studded or punched with holes. They are available in lengths from six to eight feet and weigh 1-1/4 to 1-1/3 pounds per foot. The line wires are usually wire tied to the post at a stud or hole. Steel posts are lighter to work with, easier to drive into the ground, but not as strong and often more expensive than wooden posts.

Some steel posts have an optional flat metal “spade” or anchor plate that is positioned part way up the post. This plate should be parallel to the fence line and 4 in to 6 in below the soil surface when the post is driven in. It will help prevent failure of the post by providing a greater soil contact area.

There are also specially formed steel posts that allow stapling of the fenceline wires. The cross section springs open and grips the staple. They are available under trade names such as “Staple Gripper” (that uses standard staples), or “Staple Loc” (that uses a special staple). Some claim to be 2 to 2-1/2 times stronger than standard steel posts due to their larger cross section.

Steel posts can be used to build brace assemblies in lightly loaded fences. Specially formed connectors for T-posts are used to form horizontal or diagonal braces. This “Wedge-Loc” system uses collars and wedges to construct post-to-post connections.

Concrete

Posts of concrete are used that are either farm or factory produced. When produced with the proper ratio of cement, sand, aggregate and water, in conjunction with reinforcing, they will have the following characteristics.

Advantages of Concrete Posts:

- very long life; no rot or corrosion
- will not burn
- environmentally safe—no preservative chemicals used
- uniform, attractive appearance
- can be painted
- can be cast on farm

Disadvantages of Concrete Posts:

- heavy; approximately 50 pounds or more each
- cast-in place staple inserts require posts to be driven to appropriate depths
- the staple inserts must face the right direction
- the staple inserts must be prelocated for the required wire spacings

Concrete posts can be driven into the ground using standard post drivers. The use of a rubber or steel driver cap prevents damage to the top of the post. Posts are formed with a pointed end.

Standing Trees

The use of trees along the right-of-way as fence posts is not usually recommended. Trees are growing and expanding continuously and are not suitable as posts. However if unusual conditions require the use of trees (such as rocky or swampy areas), the wires cannot be stapled directly to the tree. To prevent the wires from becoming “in-grown” a sturdy wooden nailer such as a rough cut 2x4 is first nailed to the tree and fence wires are stapled to the nailer. Use 5 or 6 inch ardox (twist surface) nails and do not drive them home but allow some “slack” so the 2x4 can still move slightly as the tree grows (expands). An inch or two of exposed nail is suggested. Some heavy bark can be removed before the nailer is installed.

Nailers are also used if wire is to be wrapped around the tree to prevent choking or eventually killing the tree. Use five or more nailers spaced around the tree.

POSTS FOR ELECTRIC FENCES

Because an electric fence is a psychological not a physical barrier, the fence posts do not require high strength. Post material may be chosen for insulation value, for instance fiberglass instead of steel posts. Post sizes will vary for permanent or temporary fences.

Posts for Permanent Electric Fences

Permanent electric fences are usually designed for long life using durable materials. Any savings gained by using lightweight posts may be at the expense of shorter life. Many permanent electric fences are constructed using pressure treated wooden posts one diameter size smaller than standard, i.e. brace posts at 3 to 4 inch diameter and line posts at 2 to 3 inch. Standard insulators can be nailed to these posts. Some permanent electric fences may use standard post sizes.

Posts for Temporary Electric Fences

Temporary electric fences are often built to be moved easily and benefit from the use of special posts. These posts will be:

- lightweight - a bundle can be carried easily
- easy to install - with a light pipe pounder or hammer; some have a plate for pushing in by foot
- may be insulating - if made of fiberglass, line insulators are not required
- may use special insulators - steel rod posts used with adjustable (sliding) insulators

Typically, posts for temporary electric fences are made of an insulating material such as fiberglass and are easy to install (without tractor equipment). Because of the small diameter of many of these posts, some offer an option anchor plate similar to those on steel fence posts. This plate should be parallel to the fenceline and 2 in to 4 in below the soil surface when the post is set. It will help support the post should livestock contact it. This contact, if the fence is properly electrified, should be infrequent.

INSTALLATION OF FENCE POSTS

A variety of equipment and methods are available to install fence posts quickly and efficiently for a wide range of post sizes and soil conditions. These methods can be summarized into the following three categories:

- dig and fill - hand dug with compacted fill; auger dug with compacted fill
- drive in - hand raised/dropped weighted driver; machine driven ram with a friction, pneumatic or hydraulic drive
- vibrate in - hydraulic driven vibrator; assisted by a weighted head or hydraulic pressure

Combinations of these methods are sometimes used, for instance partly dug and then driven in when the post height is greater than the drivers capacity. As a rule of thumb, approximately 1/3 of the full line post length should be inground; for brace posts 1/2 the length (to 4 ft maximum).

Dig and Fill

Posts set in this manner have less resistance to uplift than posts driven or vibrated in. This method is not recommended for brace posts or line posts in dips, but is sufficient for standard line posts.

Posts are set in the oversized holes, large diameter end down with backfill material placed and compacted in 6 inch layers. If this method must be used for brace or dip posts, a foot and/or thrust block can be installed, as the post is backfilled.

In cases where very hard ground is encountered, digging can be made easier if partial holes are filled with water and left to stand overnight. The saturated ground will be easier to dig the following day.

Drive In

Posts set in this manner have good resistance to uplift. Equipment varies from one to two man hand drivers (weighted pipe, with handles, that slides over the post) to tractor 3-point hitch mounted drivers. Machine drivers are preferred whenever the right-of-way terrain allows equipment access. Hand drivers are effective only on steel posts or small diameter pointed wooden posts.

Driven posts are installed small diameter end down. The natural taper of the post ensures increased ground pressure is exerted by the soil as the post is driven in. This increases uplift resistance. Large diameter posts (greater than 6 inch) may require an augured pilot hole prior to driving in some firm soils.

Vibrate In

In recent years, an improved post setting method has been demonstrated by a Kamloops inventor. Ken Fraser of Red Top Construction found that posts could be installed faster and with less post damage than the weighted driver method by using vibration. Hydraulically driven eccentric weights in a weighted “head” produced sufficient vibration to set most any post size. He has used this idea to install miles of fence. Recently the principle has been used by modifying standard vibrating soil compactors suspended in place of the bucket on excavators. Much of the highway game fencing on interior freeways (7 inch posts x 14 feet) has been installed with this method.

These units also have the ability to form a pilot hole by vibrating in a steel pipe slightly smaller in diameter than the post. They can work in frozen ground and have good ability to control the post angle in most any terrain.

Safety Concerns

Fence post drivers must be treated with respect. Considerable forces are in play in driving a post into the ground and posts often splinter. Precautions include gloves for hand protection, goggles for good eye protection and steel toe boots. Refer to Factsheet #307.050.3 ***Fence Construction Safety*** for Workers' Compensation Board and general safety concerns.

Many post drivers are supplied with a “steady fork” to be used rather than the operators hand in holding the post while driving. Also, beware that some hydraulic valves may be accidentally bumped activating the drive cylinder.

REMOVING POSTS

When a post is removed, energy should be applied in a direct upward direction sufficient to counteract the post/soil resistance. Any effort that causes the post to move in an arc must displace soil and therefore will require extra effort. For this reason, successful post pullers use either direct hydraulic uplift or a lever with a small arc on the post arm. In some cases, arcing will damage or break a post.

The larger the post and the drier/harder the ground, the larger the effort required to remove the post. Steel posts will usually be the easiest to remove.

Note: In all cases when removing posts, wear safety goggles and gloves. Use caution as significant forces are involved. Posts may suddenly release and move towards the operators.

Lever Style Removers

These have a leg with a ground foot and a head that grasps the post. An arm, which the user operates, applies pressure through a lever action applying an uplift force to the post. One model has a head specifically to grip the notches of a steel post. A lever type post remover is shown in Figure 2, below, that uses heads sized for the post, whether steel or wooden.

Hydraulic Style Removers

These may be homemade devices (low cost, one to three ton hydraulic jacks rigged in tandem on each side of a post) or the hydraulic system of a tractor (either the loader or rear hydraulics). There is a device that hangs by chains from a tractor front end loader that can remove steel posts allowing the operator to remain in the tractor seat.

A heavy duty hydraulic cylinder device is manufactured to remove posts of all sizes. Typically, these or the tractor methods use a chain wrapped tightly around the post so as to grip when pulled upward.

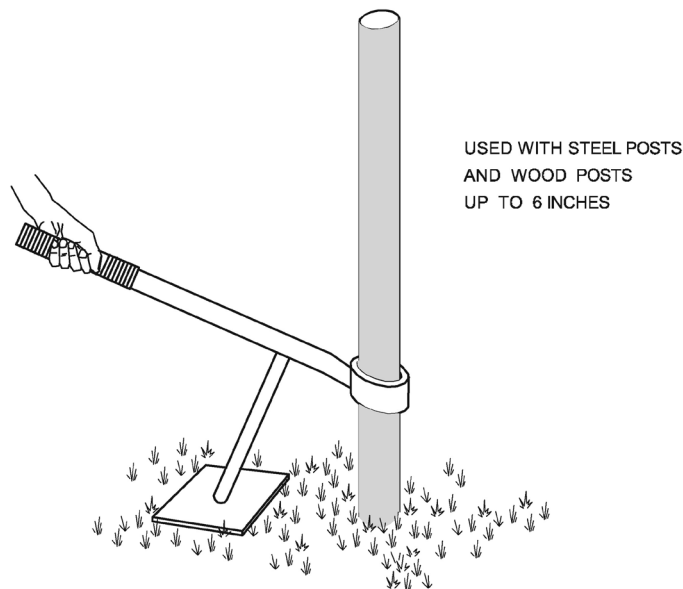


Figure 2 Lever Style Post Remover

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SPLICES FOR HIGH TENSILE SMOOTH FENCING WIRE

Are you splicing high tensile smooth wire effectively ?

The double loop knot commonly used for soft (low tensile), double-stranded barbed wire is not effective for single-strand 2.5 mm (12-1/2 ga.) high tensile wire. The best knot for tying 12-1/2 ga. high tensile wire is the figure '8', which breaks at only two thirds of the wire's strength (reference No. 1 and No. 2). To maximize the benefits of the stronger, high tensile wire, several mechanical splices can be used to obtain up to 100% of the wire's breaking strength. Strength tests were carried out at the British Columbia Institute of Technology (B.C.I.T) and by Ministry of Agriculture staff. The results show that there is a wide variation in splice strengths. Only splices which are manufactured specifically for use with high tensile, galvanized steel wire should be used. If you wish to use a splice or wire that was not intended for high tensile, smooth wire fencing, it should be submitted to a laboratory for a breaking strength test.

MECHANICAL SPLICES AND FASTENERS

Several in-line wire splices were tested at B.C.I.T. (see Table No. 1). Three commercially available mechanical splices for high tensile, smooth wire appeared suitable, including the Nicropress, Wirelink and Vineline, as each splice failed because the wire broke. (See Figure 1(a), (b) and (c), respectively). Be sure to specify the fence wire diameter and tensile strength (high or low) when ordering a mechanical splice.

Be sure to obtain and follow the manufacturer's directions. Footnotes to Table No. 1 indicate the various catalogue numbers for the wire splices used with the 12-1/2 gauge wire tested at B.C.I.T.

Although dead end splices were not tested, the three companies also have dead end wire fasteners (see Figure 2) which they claim are effective up to 100% of the wire's breaking strength.

WIRE KNOTS

Because all knots are weaker than an unjoined length of wire, the strength of the knot will determine the effective strength of any strained wire. Australian Wire Industries Pty. Limited (reference No. 1) carried out an investigation into the performance of the various knots commonly used in fencing. Some of the conclusions were:

The double loop knot cannot be recommended for use with smooth wire.

For all smooth fencing wire, the figure '8' knot decreases the wire breaking strength less than other knots and tends to be the most consistent.

The higher the tensile strength of the wire, the less reliable the knot is and the greater the tendency is to lower the strength of the wire.

Knots in barbed wire, both 2.5 mm Iowa and 1.57 mm high tensile, do not vary sufficiently to justify a recommendation for a particular knot. Ease of tying becomes the deciding factor.

Table No. 2, shows the efficiency of the figure '8' knot and the double loop knot expressed as a percentage of the breaking strength of the wire. Figure 3, shows the figure '8' double loop and tie-off knot. The tie-off knot is reported to be effective up to 60% of the breaking strength of high tensile wire (reference No. 2).

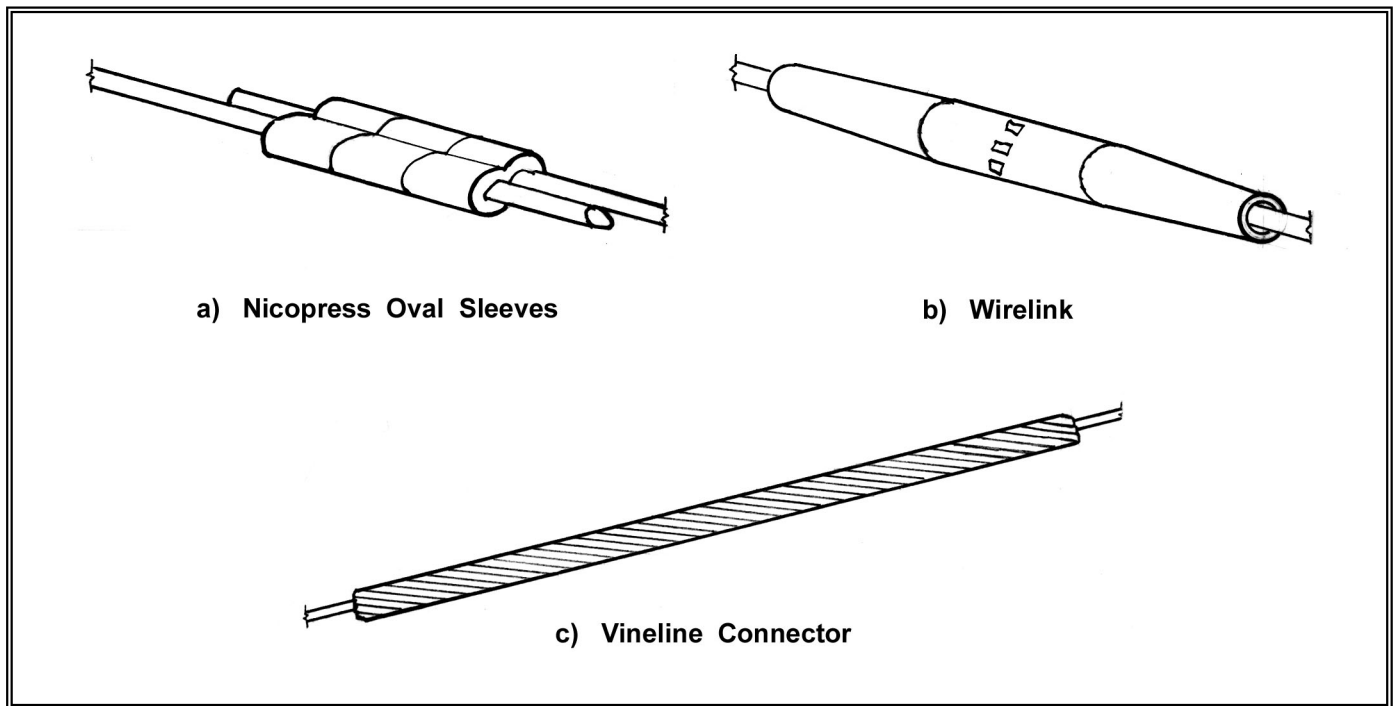


Figure 1

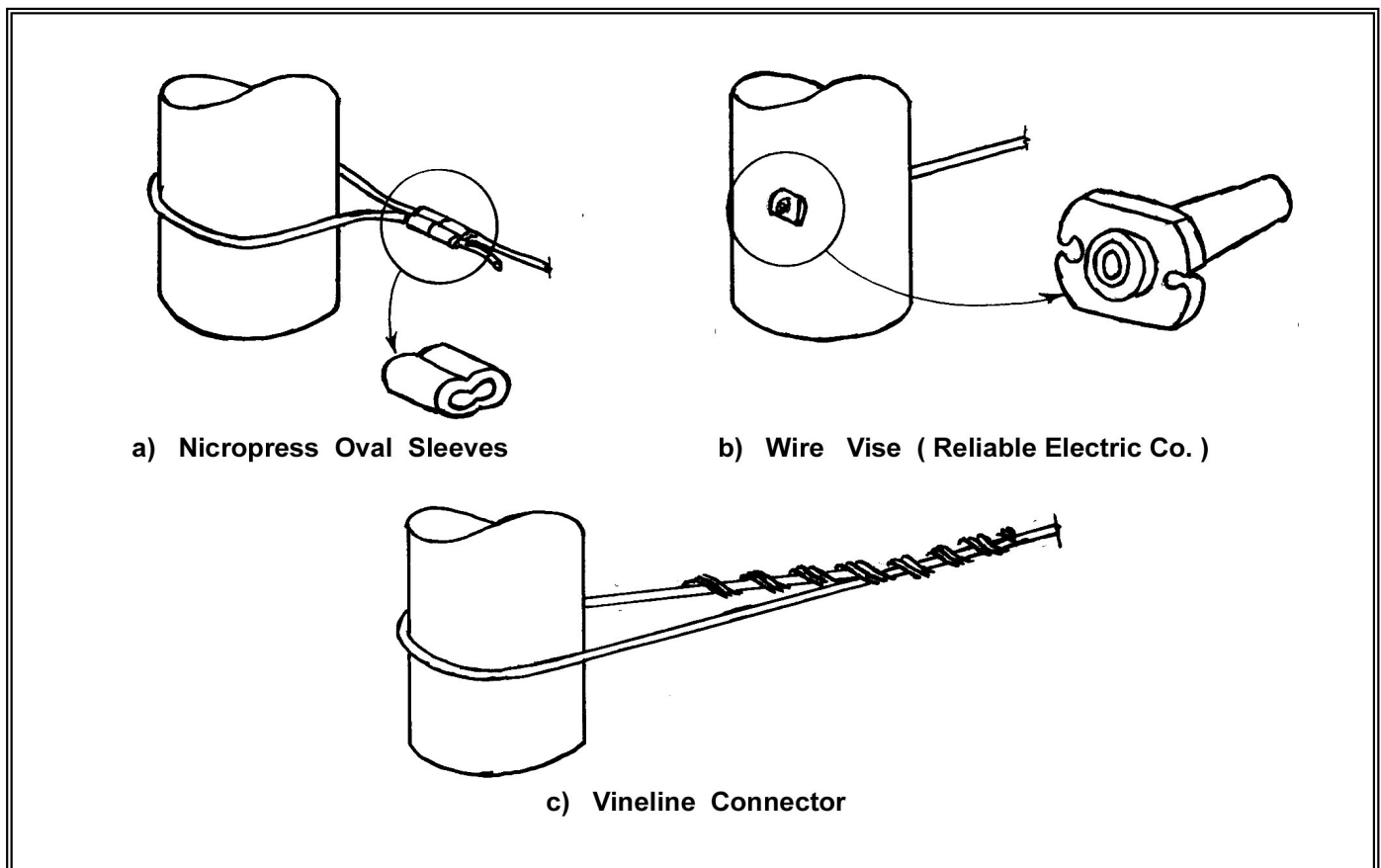


Figure 2

TABLE No. 1

WIRE	CONNECTOR	BREAKING STRENGTH	% OF WIRE STRENGTH
Sample A ¹	None	6090 N (1370 lb)	100
Sample B	None	6890 N (1550 lb)	100
Sample C	None	8320 N (1870 lb)	100
Sample D	None	7340 N (1650 lb)	100
Sample D	1 FW2-3 sleeve ²	3650 N (820 lb)	50 *
Sample D	2 FW2-3 sleeves ²	6850 N (1540 lb)	93 *
Sample D	3 FW2-3 sleeves ²	7340 N (1650 lb)	100 **
Sample D	Wirelink ³	7160 N (1610 lb)	98 **
Sample D	Vine-Line ⁴	7290 N (1640 lb)	99 **
Sample C	3 FW2-3 sleeves ²	8320 N (1870 lb)	100 *
Sample C	3 aluminum sleeves ⁵	3510 N (970 lb)	42 *
Sample D	3 copper sleeves ⁶	2200 N (490 lb)	30 *

- Many of the wire manufacturers are willing to manufacture wire to a tensile strength specified by their customer. Samples A, B, C and D were all sold as 12-1/2 gauge, high tensile, smooth fencing wire.
- The FW2-3 is a Nicropress (™ National Telephone Supply Co.) oval sleeve for lap splicing 12-1/2 gauge (2.5 mm wire diameter) wire that is crimped with a Nicropress tool No. 64-2345 or FT-2345. Nicropress recommends for regular strength fence wire, both single and double strand barbed wire, use one oval sleeve for a lap splice and one oval sleeve for an eye splice (dead-end). For high strength fence wire, use three sleeves for a lap splice and two sleeves for an eye splice. Sleeves are available for many gauges of single-strand wire and two-strand barbed wire for use with the same Nicropress tool.

- The Wirelink (™ Reliable Electric Company) is a butt splice; catalogue No 5059 is intended for wire diameters 2.6 – 2.9 mm (.102 - .114 in).
- The Vine-Line (™ Performed Line Products Company) connector; Catalogue No. 2602-102.
- Aluminum oval sleeves by an unknown manufacturer crimped with a home-made crimping tool (hole filed in both cutters).
- Copper oval sleeve: same size as Nicropress FW2-3 sleeve crimped with Nicropress tool No. 64-2345.

* These in-line splices failed at the strength indicated because the wire slipped through the splice.

** These in-line splices failed at the strength indicated because the wire broke.

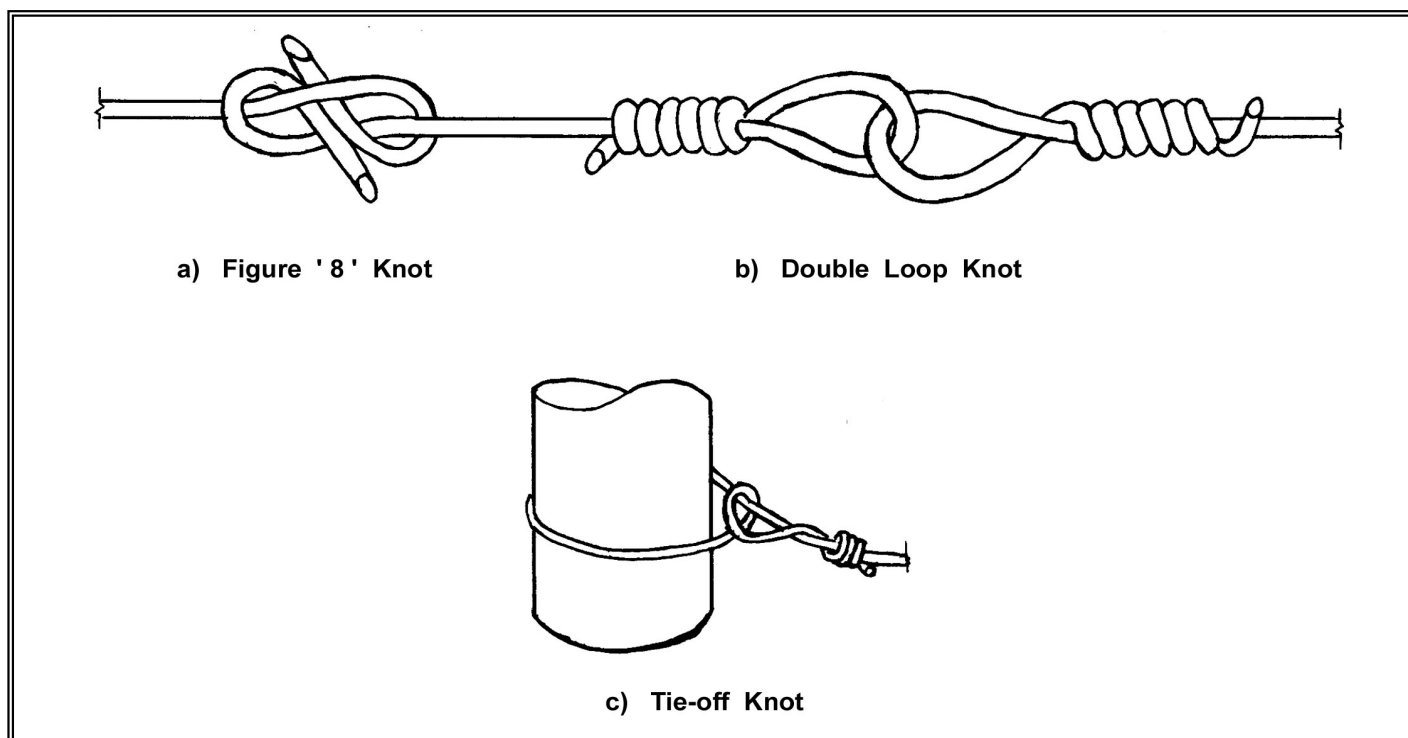


Figure 3

TABLE No. 1
(From Reference 2)

KNOT	WIRE TYPE					
	.4 mm	.315 mm	H.T. Ty-Easy 2.8 mm	2.5 mm	Iowa Barbed Wire	H.T. Barbed Wire
Figure '8' Loop	80%	74%	66%	68%	74%	66%
Double Loop	69%	63%	46%	48%	88%	61%

REFERENCES

- (1) *Waratah Fence Manual*. 1981. Australian Wire Industries Pty. Limited.
- (2) *How to Build Fences with U.S.S. MAX-TEN 200 High Tensile Fence Wire*. May 1980. United States Steel Corporation, Pittsburgh, Pennsylvania 1530. U.S.S. Catalogue No. T-111575.

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WIRE FENCE CONSTRUCTION

This factsheet discusses construction of wire fences (barbed wire, high tensile smooth wire, woven wire and electric) from right-of-way preparation to hanging gates. It also illustrates construction methods on curves and through gullies.

RIGHT-OF-WAY PREPARATION

During the initial planning stage, the fence purpose, type of animal and site conditions are used in choosing a fence design. These points must be kept in mind when preparing the right-of-way and laying out the fence.

There are two basic types of fence right-of-ways:

- boundary fence right-of-way
 - these fences have predetermined locations
 - right-of-way work may be restricted to the builders side
- general farm fence right-of-way
 - right-of-way location less restricted
 - right-of-way can be chosen to suit the builder

Preparation will vary greatly: forested sites will require logging; bushed sites may be mowed; grasslands may need little preparation. A well prepared right-of-way with good access assures a work area than can only help the fence builder.

Decisions made in preparing the right-of-way have effects through construction, use and maintenance of the fence. Some points to consider:

Plan. Know the area well before finalizing the right-of-way.

Access. Prepare the right-of-way so a fence line can be laid out with good access to both sides (i.e., for a cattle range fence, ensure a horse & rider will be able to move along both sides of the fence after it is constructed).

Straightness. Keep the right-of-way as straight as possible to simplify wire fence construction; all-wood fences have less need for a straight right-of-way.

Direction Changes. Right-of-way changes of direction should be done keeping in mind the ideal tensioning distances of wire; 660 feet (barbed and woven) and 1,320 feet (htsw). Because tie-off braces will be located at these approximate distances, change of direction at these locations will not add greatly to fence costs.

Uneven Terrain. Remove minor undulations where possible but consider seasonal water flows when filling dips or gullies. Culverts or flood gates may be required.

Windfalls. Remove dead, defective or leaning trees that could fall across the fence.

Slash. Pile and burn all slash and waste wood (or cut & leave to rot) to ensure the right-of-way is passable.

Visibility. Some right-of-ways may have to be prepared using low impact methods if visibility is a concern.

Right-of-Way Vegetation

Although this is done after fence construction, it is important to remember that all disturbed soil from right-of-way preparation should be seeded to grasses to discourage weed growth.

FENCE LINE LAYOUT

Once the right-of-way has been prepared, the actual fence line location can be established. There are two typical situations depending on who the builder is:

- owner built – assuming you know what you want, flag the fence line as required
- contractor built – be certain he knows your instructions **and** you flag well to identify everything required

Fence line layout along the right-of-way is commonly done using plastic flagging tape. Choose a bright, easy to see colour that is not already used in the area of the right-of-way, and:

- using single flags (or sight stakes if needed), place often enough so you can stand at one and see the next - at dips or rises, extra flags or sight stakes will be required to ensure a straight fence line as shown in Figure 1, below
- using double flags, mark all changes of direction, gates, or other instructions - use a felt pen to write on the flag what is required (such as corner brace, etc)

Note that tie-off points may be up to the distances recommended by the wire type above. At this point, a detailed materials list can be assembled, materials ordered, delivered to the site and construction can start.

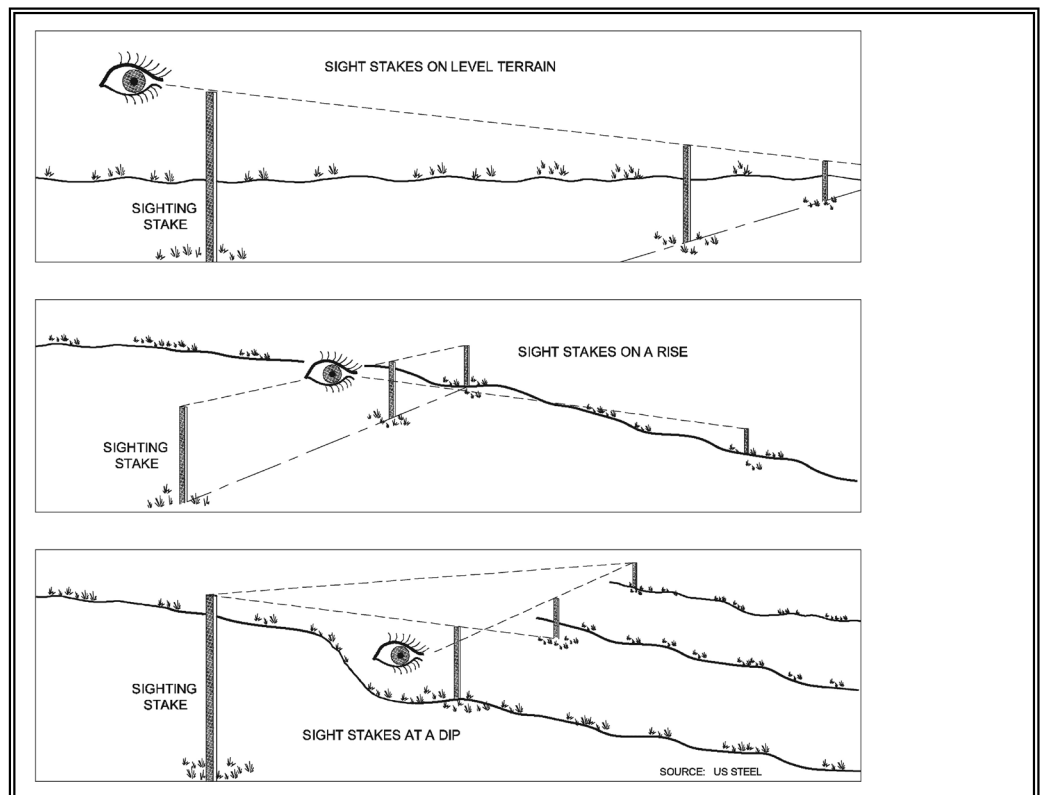


Figure 1 Fence Line Layout Using Sight Stakes

10-STEP CONSTRUCTION SEQUENCE

The following 10-Step Sequence has been written for construction of a high tensile smooth wire (htsw) fence on a properly prepared right-of-way. Sequences for barbed wire, woven wire and electric htsw follow, listing only the points that are different from this 10-Step Sequence. All materials are assumed to be on site.

HTSW Construction Sequence

1. Locate and prepare the right-of-way.

2. Flag fence line.

3. Install end, rise, dip, change of direction and gate posts. This may require the use of sight stakes as shown in Figure 1, page 2. Add pull out resistance to dip posts as needed.

4. String the first fence wire as a guide wire. Tie off at the far end post and return stapling onto posts at height of bottom wire. Pull hand tight and tie off at the first end post (sight stakes can be removed in the pass).

5. Install all brace and line posts - if the soil conditions are favourable, proceed in one pass in alignment with the guide wire. If problems are expected in installing the remaining brace posts due to ground conditions, these should first of all be installed at all locations. This may require an extra pass along the fence line, but at this point brace location can still be moved a few feet if posts cannot be set deep enough. Mark wire heights on each post if not using a “stapling stick”.

6. Build braces.

7. String and staple the remaining line wires:

- pull one strand out at a time, tie off at the far end post, staple on return, hand pull tight and tie off at first end post;

Or:

- pull all remaining strands out at once - this can be done easiest by tying each wire off at the first end post and taking all these remaining rolls down the right-of-way
- mount one wire roll per strand on an ATV, tractor or pickup truck (Figure 2, below); use a “stapling stick” to staple each wire in the proper order and height on line posts (Figure 3, next page); hand pull tight and tie off at far end post.

8. Tension all wires to 250 lb. starting at the top wire. This can be done in increments or all at once, however tension can change as each strand is tightened. Expect to do each wire twice to achieve final tension. Use a tensioner designed for htsw.

9. Install droppers if used.

10. Hang gates.

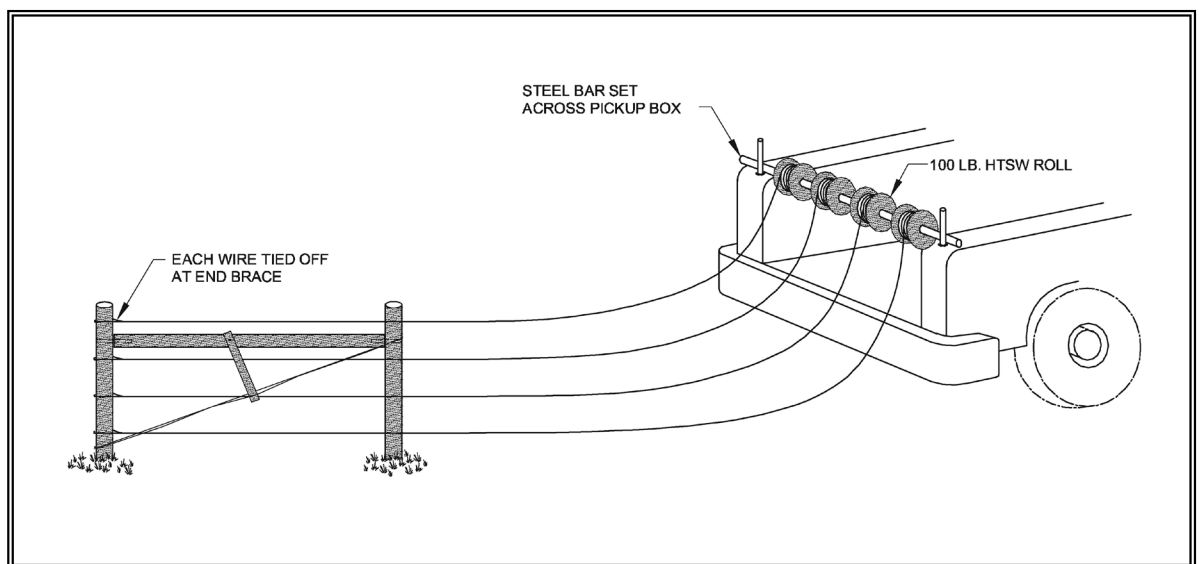


Figure 2

Stringing Out Multiple Wires At Once



Figure 3

Stapling Stick for Multiple Wires

Barbed Wire Construction Sequence

NOTE The following are only the points differing from the 10-Step Sequence, page 3.

The most important difference in the barbed wire construction sequence is the need to pretension barbed wire prior to stapling.

4. Guide wire - barbed wire is not as convenient to use as htsw for the guide/bottom fence wire unless the fence is on level terrain. Because barbed wire must be tensioned before stapling, it is difficult to string properly through gullies, etc. Once stapled, it cannot be retensioned as barbs will catch on the staples. Consider using a smooth wire or cord for a guide wire.

7. String line wires (don't staple):

- Pull one strand out at a time, tie off at the far end post and return to the start for the next strand (stringing multiple strands of barbed wire at once is not recommended).

8. Prestretch double strand barbed wire to 600 lb. and relax to the operating tension of 250 lb. On level terrain, the wire can now be tied off at the end post. On undulating terrain, a lower (estimated) tension must be used and then tied off **prior** to the wire being pulled down on dip posts or up on rise posts (which will increase tension). Start tensioning with the top wire as for htsw.

Staple wire onto line posts.

Woven Wire Construction Sequence

NOTE The following are only the points differing from the 10-Step Sequence, page 3.

4. String the guide wire. Use htsw or cord.

7. Ready the woven wire:

- play out the wire either by keeping the roll vertical on a tractor support device or rolling it out on the ground
- join roll sections for the appropriate length
- tie off one end at the first end post

8. Tension the woven wire:

Using the “one-end” method (Figure 4, page 6) where the wire is tied off at one end and then tensioned to the second end brace:

- attach the clamp bar to the wire past the second end brace;
- stand the wire vertical (if it’s not already);
- pull from clamp bars to a suitable anchor support (such as a tractor) using a come-a-long (note: a tractor may be used to pull the wire up to tension instead of the come-a-long if a very low “crawl” gear is selected - **this however is not recommended due to the possibility of over-tensioning the wire and the danger to the operator should the wire break**)
- tie off the tensioned wire to the end post by carefully cutting one horizontal strand at a time (well past the brace) and tying to the end brace post.

Or:

Using the “two end” method (Figure 5, page 6) where two wire sections are tied off at end braces and then tensioned towards each other then spliced:

- attach a clamp bar to the end of each wire section;
- attach the pulling device to the clamp bars;
- stand the wire vertical (if it’s not already);
- tension;
- cut and splice each horizontal strand (one at a time);
- release the puller and remove the two clamp bars.
- staple the wire onto line posts.

9. No droppers are used in woven wire fences; disregard this step.

Permanent Electric Fence Sequence

NOTE The following are only the points differing from the 10-Step Sequence, page 3.

As neither barbed nor woven wire is normally electrified, it is assumed the following permanent electric fence uses htsw.

7. String the remaining line wires:

- grounded wires – as for htsw using standard tie offs and staples
- electrified wires – as for htsw but use insulated tie offs and insulators on line posts

8. Tension all wires 100 to 150 lb. starting at the top wire.

9. Droppers are not normally used; disregard this step.

10. Hang gates and run lead wires over or under the gate as required.

In addition to the 10-Step Sequence, for permanent electric fences:

11. Install ground system for energizer and for grounded fence wires where required.

12. Install fence energizer and attach leads to fence wires.

Temporary Electric Fence Sequence

NOTE as temporary electric fences generally require no right-of-way preparation or braces, the following is not comparable to previous sequences, requiring six steps.

1. Hand set line posts (rebar, steel ‘T’ post, fibreglass or light wood). Set suitable end posts for tie off.

2. String out line wire(s) on ground and tie off at far end post.

3. Attach insulators and lift wire(s) in place returning to the first end post.

4. Hand pull slack and tie off at the first end post. If this is a cross fence running from a permanent fence, use one of these line posts to tie off the temporary wires.

5. Install ground system for energizer and for grounded fence wires where required.

6. Install fence energizer and attach leads to fence wires.

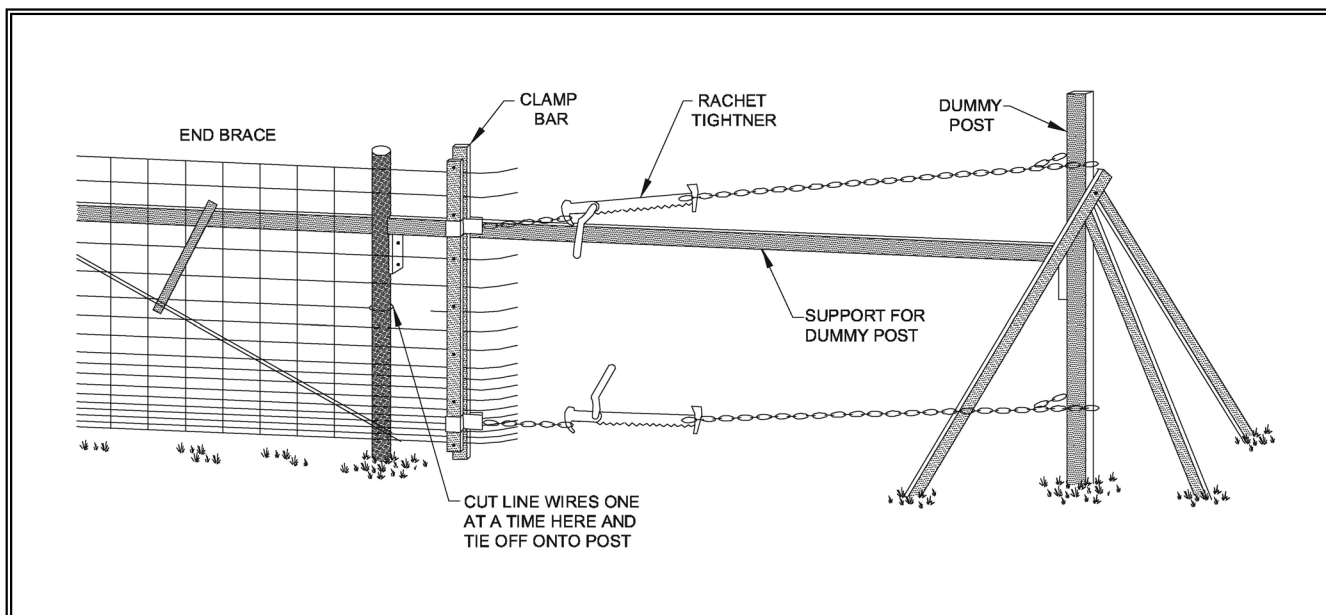


Figure 4 **Tensioning Woven Wire From One End**

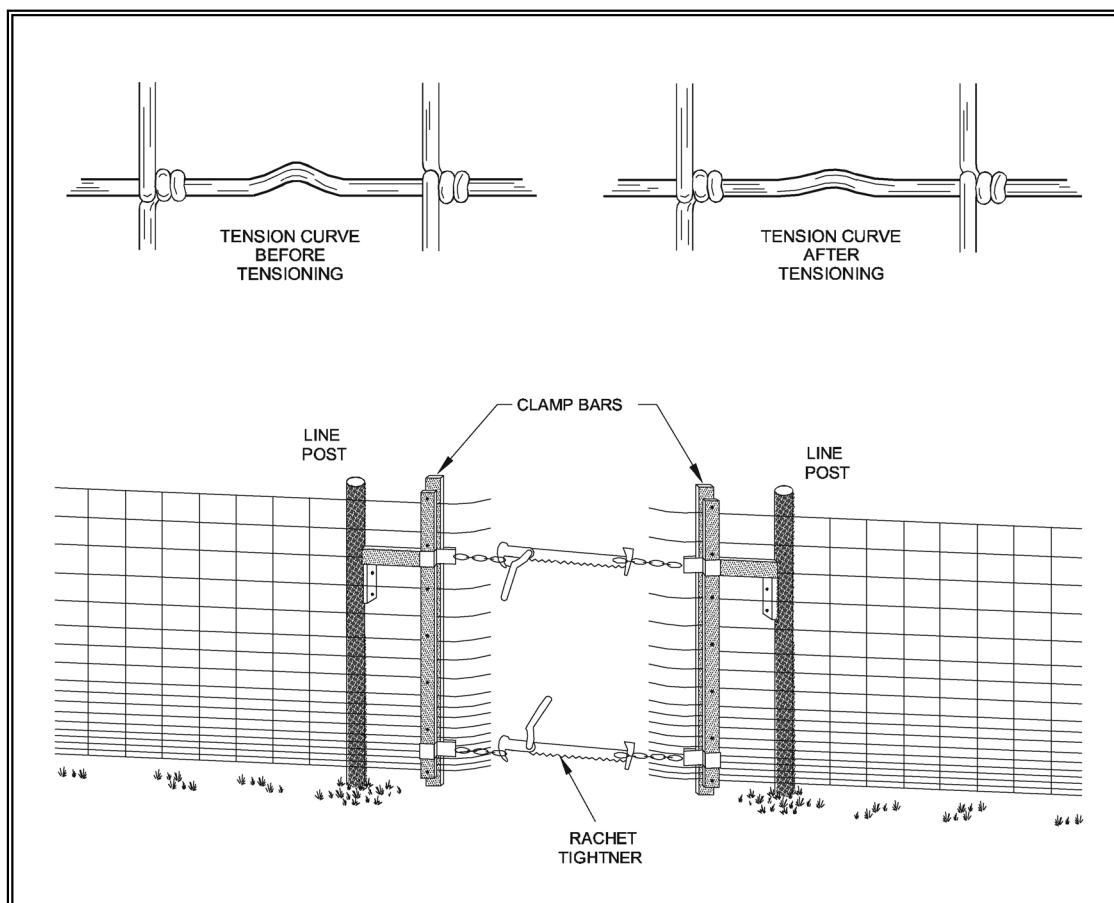


Figure 5 **Tensioning Woven Wire From Two Ends**

SPECIAL FENCING PROBLEMS

Many unique problems arise when constructing a tensioned-wire fence. These often relate to the terrain of the right-of-way, such as gullies, watercourses and fencing around curves. These all require special posting solutions.

Fencing On Slopes

When installing posts on level ground, the post is set perpendicular to the ground (this is also plumb) and the fence wires, when attached, are perpendicular to the posts (parallel to the ground). Everyone would consider this a normal fence.

However when posting on slopes some differences arise. Going up a slope, if the posts are set plumb they will not be perpendicular to the wires. On a steep slope, plumb posts will be easier to overturn as they will be at a shallow angle to the ground (already leaning) and therefore not able to perform properly.

Going across a slope, posts perpendicular to the ground will appear to be inadequate for livestock on the upper slope side as the posts will be leaning down slope.

While it may seem unsightly to the eye, **posts should always be installed perpendicular to the ground on fence lines up and down slopes and plumb going across slopes** as in Figure 6, below. This will produce the strongest fence at the proper height. On very slight slopes this is not as important as it is on steep slopes. Some post drivers will not be able to work perpendicularly to steep slopes.

Fence wires can be on either side of the posts. Choose the side with the greatest livestock pressure; for fences along slopes this is usually the upslope side of the post.

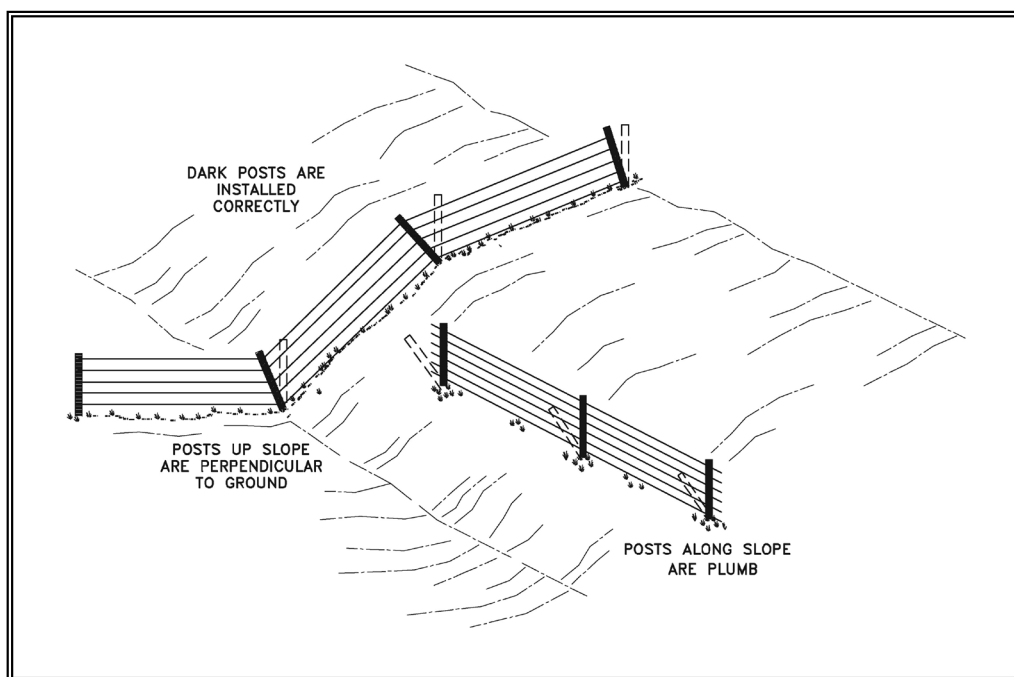


Figure 6 Installing Fence Posts on Slopes

Fencing Through Gullies

When fencing across a dip or gully, posts set in the bottom will have an uplift force applied when the fence wires are tensioned. The greatest uplift will be on the bottom gully post(s) and will be in relation to the fence angle change through the gully (i.e. to the relationship of the width and depth of the gully). Narrow, deep gullies cause the greatest uplift conditions.

Successful fences require some means to ensure these gully posts will remain securely in the ground. Six solutions are used depending on the degree of uplift:

1. Add weight to the gully post

- rocks wired to hang from the post for very slight gullies
- or rock jacks constructed around posts then rock added for greater weight
- limited due to amount of rock practical to place on post

2. Oversize the gully post

- similar to brace posts, use larger diameter, set post deeper or use two posts close together to increase uplift resistance
- suitable for slight to medium gullies

3. "Brace" the gully post

- wire from the top of the gully post to the bottom on each neighbouring line post as shown in Figure 7, below
- suitable for slight to medium gullies

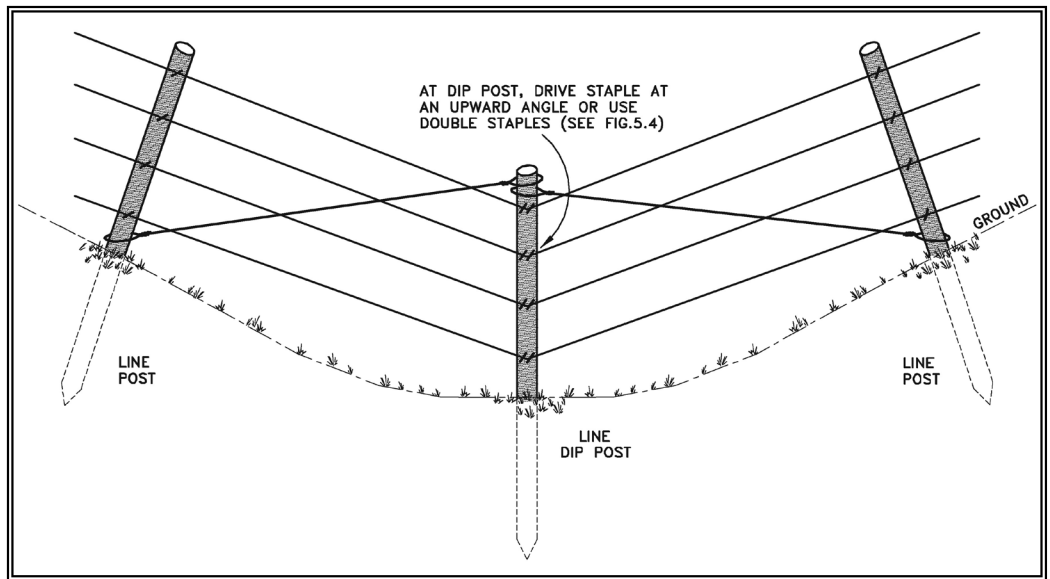


Figure 7 **Wire Bracing a Dip Post**

4. "Foot" the gully post

- increase the pull out resistance by adding a foot to the dip post
- use a 3 to 4 foot length of steel fence post driven in at 45 degrees at the base of the post then wired to the post as shown in Figure 8, next page
- or a wood foot can be constructed. Note this requires digging a hole around the post if the post was driven into the ground

5. "Over-fence" the gully

- the main tensioned wires are strung to run continuously over the gully
- a "dummy" fence under low wire tension runs through the gully which puts very little up-lift on the gully posts
- suitable for a narrow gully or waterway as shown in Figure 9, next page

6. "Separate-fence" the gully

- the main fence is completed with end braces on either side of the gully
- the gully section is fenced separately with reduced wire tensioning
- most suitable for wide gullies as shown in Figure 10, next page



Figure 8 Footing a Dip Post



Figure 9 Over-Fencing a Gully

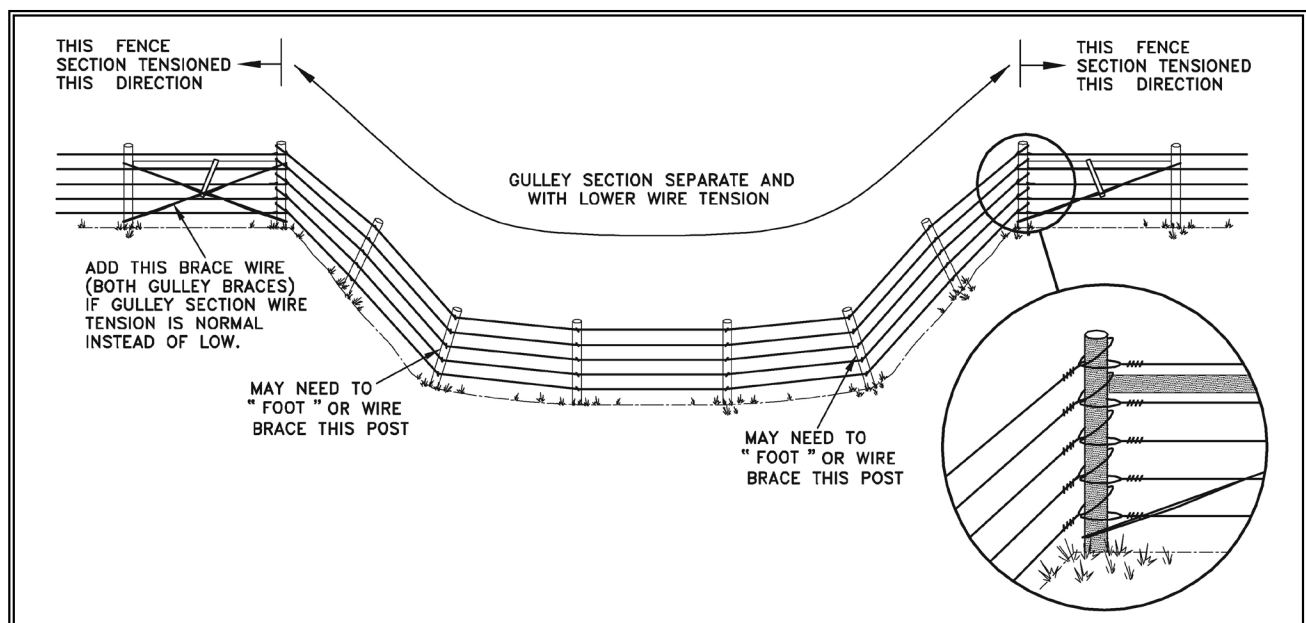


Figure 10 Separate-Fencing a Gully

Fencing Over Small Water Bodies

Another fencing problem arises where a fence line encounters a gully with a stream or small water body. For instance, a gully that is subject to seasonal water flows. In these cases a fencing method should be selected to protect the main fence away from the gully from possible water damage. This damage could range from soft soil reducing the retention of the gully posts, to flood damage affecting the entire gully fence section. To limit such possible damage to only the gully fence section, either of the following two procedures are recommended:

1. Floodgate the gully (suitable for narrow gullies with high seasonal water flows)
 - over-fence the gully as previously shown but instead of a dummy gully fence, hang a floodgate - refer to Factsheet 307.400-1 *Gates, Cattleguards and Passageways*
2. “Breakaway” fence the gully (suitable for wide gullies with high seasonal water flows)
 - using either gully fence methods previously shown in Figures 9 or 10 but post the gully sections separate from the main fence as shown in Figure 11, below using a brace-sized post driven $3\frac{1}{2}$ feet (min)

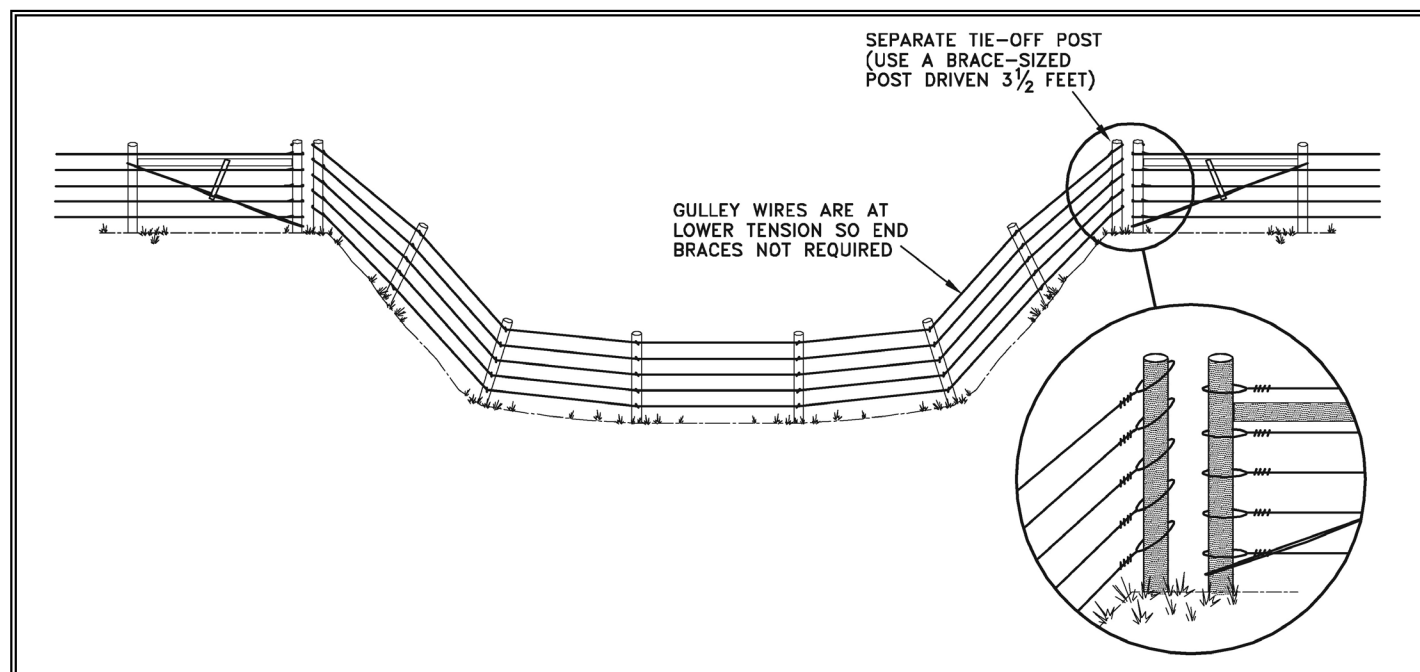


Figure 11 Breakaway Fencing a Gully

Fencing Around Curves

Fencing at corners is discussed in Factsheet 307.220-1 *Brace Assemblies for Wire Fences – What They Are, How They Work, How to Construct Them* with the use of braces. However when fencing around gradual curves, the fence wires can be supported without constructing braces by using various single posting methods.

For gradual curves, rather than have many short sections of fence, the fence wires can continue around a change of direction post(s) provided they can be adequately set. Shown in Figure 12, below, it is suitable for fences with up to 6 wires on gradual curves and direction changes less than 60° (for greater changes use braces). For every 20° of fence direction change (about 3 feet 8 inch angle change over 10 feet of fence line):

- space a post 4 feet
- use posts one diameter size larger than line posts
- set them a minimum 3 feet deep
- set with 4 in top lean into the wires (away from the curve center)

Firm soil conditions are required. Special stapling techniques are used to reduce wire-to-post friction around posts (refer to Factsheet 307.100-2 *Fence Wire: - Dispensing, Stapling, Joining, Tying, Tensioning and Grounding*).

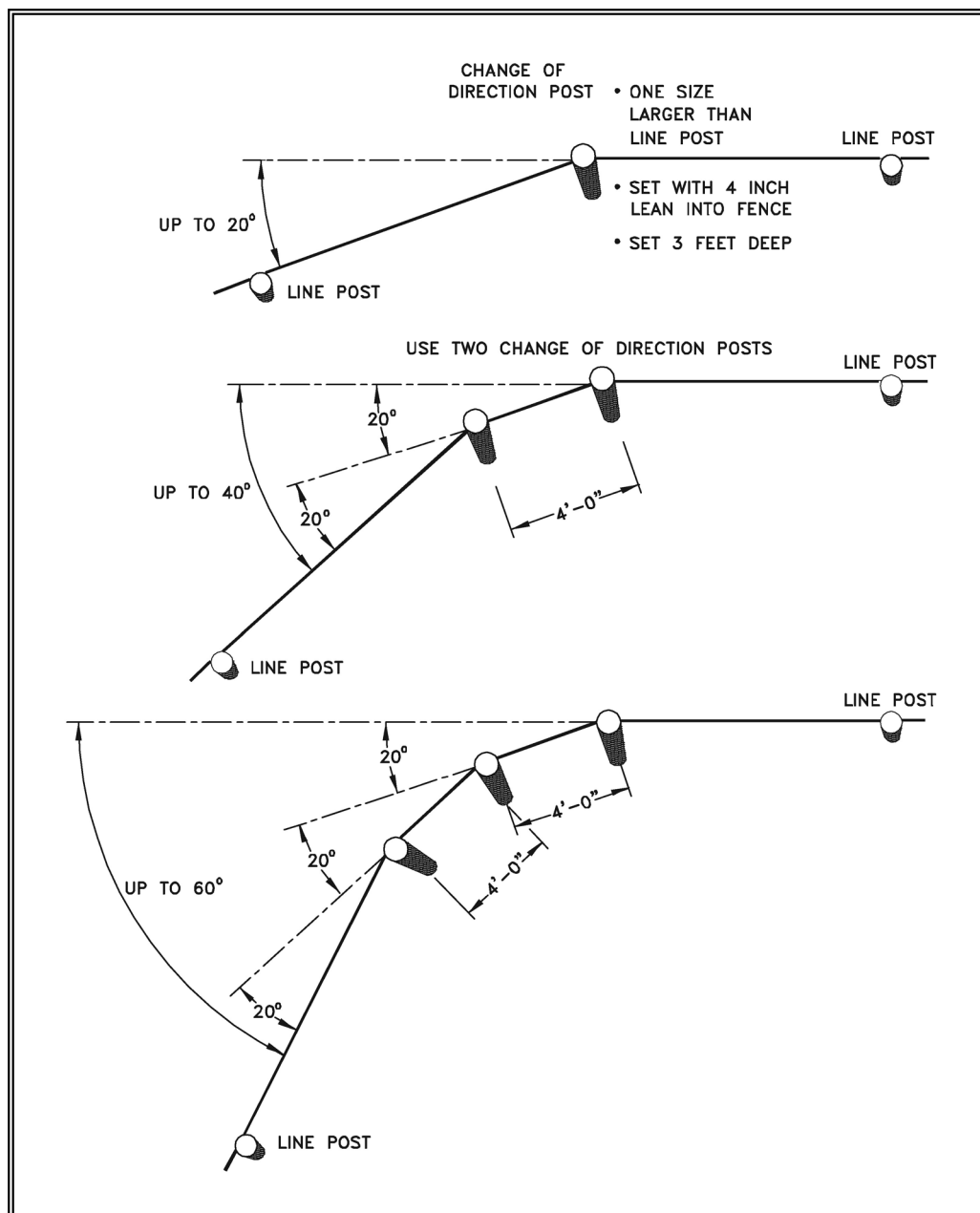


Figure 12 **Posting Around Gradual Curves**

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Fencing FACTSHEET



Order No. 307.600-2
Revised December 2015

WOOD FENCE CONSTRUCTION

This factsheet discusses construction of Post and Rail, Snake Rail, Log and Block, and Russell Fences, along with right-of-way preparation information.

RIGHT-OF-WAY PREPARATION

During the initial planning stage, the fence purpose, type of animal and site conditions are used in choosing a fence design. These points must also be kept in mind when preparing the right-of-way and laying out the fence.

There are two basic types of fence right-of-ways:

- boundary fence right-of-way
 - these fences have predetermined locations
 - right-of-way work may be restricted to the builders side of the right-of-way
- general farm fence right-of-way
 - right-of-way location is less restricted
 - right-of-way can be chosen to suit the builder

Preparation will vary greatly: forested sites will require logging; bushed sites may be mowed; grasslands may need little preparation. A well prepared right-of-way with good access assures a work area that can help the fence builder and result in a good fence. Good right-of-ways are also important for fence maintenance, etc.

Decisions made in preparing the right-of-way have effects through construction, use and maintenance of the fence. Some points to consider:

Plan. Know the area well before finalizing the right-of-way.

Access. Prepare the right-of-way so a fence line can be laid out with good access to both sides (i.e., for a cattle range fence, ensure a horse & rider will be able to move along both sides of the fence after it is constructed).

Straightness. Keep the right-of-way as straight as possible to simplify wire fence construction; all-wood fences have less need for a straight right-of-way.

Direction Changes. Right-of-way changes of direction should be done keeping in mind the ideal tensioning distances of wire; 660 feet (barbed and woven) and 1,320 feet (htsw). Because tie-off braces will be located at these approximate distances, change of direction at these locations will not add greatly to fence costs.

Uneven Terrain. Remove minor undulations where possible but consider seasonal water flows when filling dips or gullies. Culverts or flood gates may be required.

Windfalls. Remove dead, defective or leaning trees that could fall across the fence.

Right-of-Way Vegetation

Slash. Pile and burn all slash and waste wood (or cut and leave to rot) to ensure the right-of-way is passable.

Visibility. Some right-of-ways may have to be prepared using low impact methods if visibility is a concern.

Although this is done after fence construction, it is important to remember that all disturbed soil from right-of-way preparation should be seeded to grasses to discourage weed growth.

FENCE LINE LAYOUT

Once the right-of-way has been prepared, the actual fence line location can be established. There are two typical situations depending on who the builder is:

- owner built – as you know what you want, flag the fence line as required
- contractor built – be certain he knows your instructions **and** you flag well to identify everything required

Fence line layout along the right-of-way is commonly done using plastic flagging tape. Choose a bright, easy to see colour, and:

- using single flags (or sight stakes if needed), place often enough so you can stand at one and see the next - at dips or rises, extra flags or sight stakes will be required to ensure a straight fence line as shown in Figure 1, below
- using double flags, mark all changes of direction, gates, or other instructions - use a felt pen to write on the flag what is required (such as corner brace, etc)

Note that tie-off points may be up to the distances as recommended for the type of fence wire. At this point, a detailed materials list can be assembled, materials ordered, delivered to the site and construction can start.

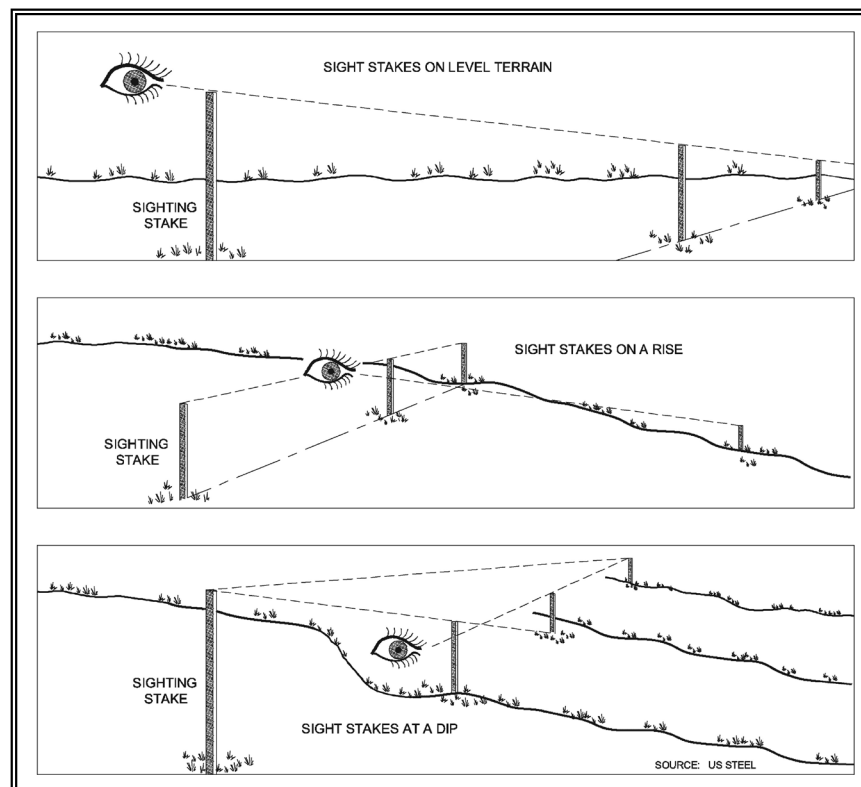


Figure 1 Fence Line Layout Using Sight Stakes

CONSTRUCTION OF ALL WOOD FENCES

These type of fences range from the easiest to build (Post and Rail) to among the most difficult to build (Russell Fence).

A Note About Nails

Spiral shank nails have up to twice the holding power of the same sized smooth shank nails. Sold under the Ardox name, these nails are often chosen for fencing applications such as joining wooden rails to posts. Ardox nails have a smaller diameter shank than the same size smooth shank nail, are made of a higher grade steel and their per-nail-cost can be lower.

Post and Rail Fence Construction

See post and rail design information on page 5 of Factsheet 307.260-1, *Livestock Control, Non-Electric Fence Designs*.

- Post spacing is governed by the rail length available; allowing approximately 6 inches of rail length at each post for 'overlap', the post spacing is then 1 foot less than the rail length.
- Rails may be staggered (over/under) or slanted from post to post as suits the builders 'eye'. Rails are applied to the animal side of the posts. Otherwise, vertical boards are attached at each post over the rails and wired to the post to ensure the security of the fence.
- Alternatively, rails can be butt joined at the posts if the rails are twice the length of the post spacing; stagger the joints so they are not all on the same post.
- Board rails may be nailed directly to posts; round rails should be notched with an axe. Cut a curved 'scoop' type of notch in the round rail to mate with the curved surface of the post to ensure a proper rail-to-post connection.
- For most livestock, use rough cut, unplanned boards for rails; if round rails are used, peel the bark off on a minimum three sides.
- Use spiral shank (Ardox type) nails for superior holding strength; one nail per round rail-to-post connection or two per board-to-post connection.
- Flat steel washers used with nails will increase the nail head area for greater holding strength.

Snake Rail Fence Construction 3-Log

See Figure 2 below and design information on page 6 of Factsheet 307.260-1 *Livestock Control, Non-Electric Fence Designs*.

The following is the "even stacked" method where each log has both ends on top of the previous log (not shown here, the "uneven stacked" method is where each log has one end on top of the last log and the other end under the next log).

- Ensure sufficient right-of-way width to accommodate this 'wide' fence style.
- Note that all rail notches are on the underside of the rail to prevent water from accumulating and causing wood rot.
- Follow the procedure below as shown in Figure 2.
- String a guide wire or string approximately one foot to the fence side of the 'end-of-log' sight line.

- Use peeled wooden starter blocks (pressure treated preferred; or flat rocks where available) set out the panel length for the first panel. The first block will be set at the guide wire and the other set to the fence side to establish the 'snake' (the second block will be the panel length from the first and the panel width from the guide wire). See Figure 2 (A)
- Notch the first regular panel, bottom rail, to fit the blocks and set in place.
- The starter panel is then laid out. It is different from the first regular fence panel as it must be self supporting. To do this, a triangular panel is constructed as the first few regular panels go up. After this starter panel is complete, the fence progresses normally.
- Set the starter panel block about 6 or 7 feet away from the first panel block and about the same distance from the first panel, bottom log. Notch and set the first row starter log (about one-half a regular log length) on this starter block and back onto the midpoint of the bottom first panel rail (make a small notch so it will sit on this rail). See Figure 2 (B)
- Notch and lay the second starter log on top of the first starter log/block and over to the bottom first panel log, forming the first starter triangle.
- Before the first panel, second row log can be set, the second to fifth panels must be started i.e., the first, third and fifth panels will each have the two starter blocks set and each will have the bottom log notched and set in place). See Figure 2 (C)
- The first row log can now be set in the second and forth panels (notched and set on top of the bottom logs of the adjacent panels). See Figure 2 (D)
- The second row log in the first and third panels is notched and set. See Figure 2 (E)
- The two second row end starter logs are notched and set in place.
- The second row log in the second panel is notched and set in place.
- The third row (last log) in the first panel is notched and set in place.
- With the triangular starter panel two logs high and the first regular panel three logs high the fence is underway. Each panel can now be completed as sufficient panels are started in advance.
- The fence is ended similarly as it was started; a triangular end panel is constructed.
- Wire tie the top log at each end to the log beneath for security.

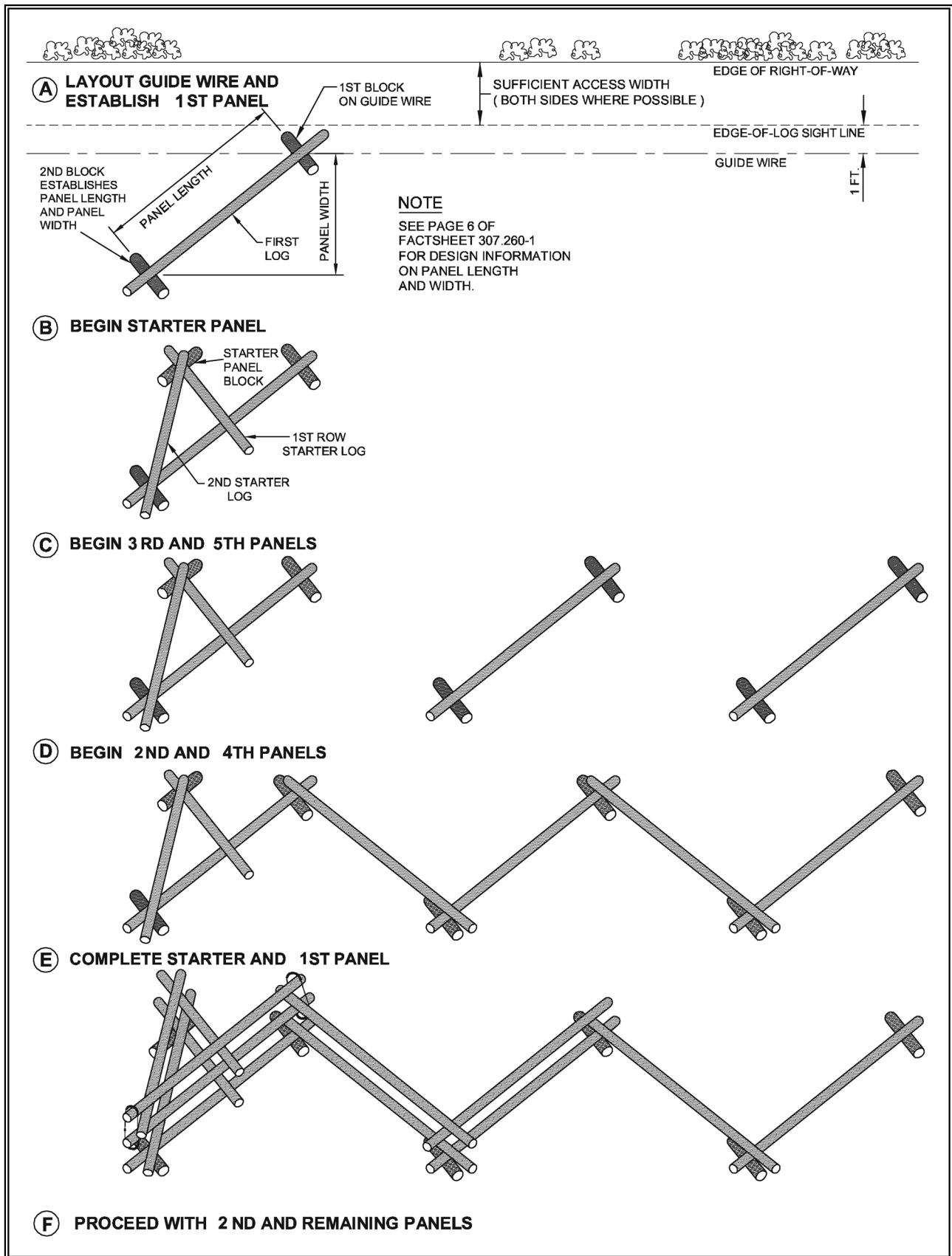


Figure 2

3-Log Snake Rail Fence Construction

Log and Block Fence Construction

See log and block design information on page 7 of Factsheet 307.260-1 *Livestock Control, Non-Electric Fence Designs*.

- This fence is essentially a modified snake rail fence but constructed in the same manner.



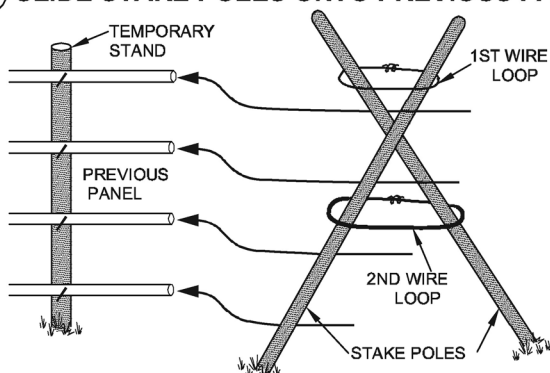
Russell Fence Construction

See Figure 3 below and design information on page 8 of Factsheet 307.260-1 *Livestock Control, Non-Electric Fence Designs*.

- These fences are constructed with four to five rails, two to four inches in diameter
- The top rail is supported in the cross of the stake poles. See Figure 3 (A)
- The second rail sets in the second wire loop. See Figure 3 (B)
- The third and fourth rails hang in the third wire loop. See Figure 3 (C)
- The key to this fence is the two tie poles which are inserted into the first wire loop and rotated so as to tighten the assembly. See Figure 3 (D)
- The tie poles meet the adjacent tie poles at mid-panel and are wire tied to the bottom rail only.
- Experience is required to judge the wire loop sizes, the twisting of the third wire loop, etc.

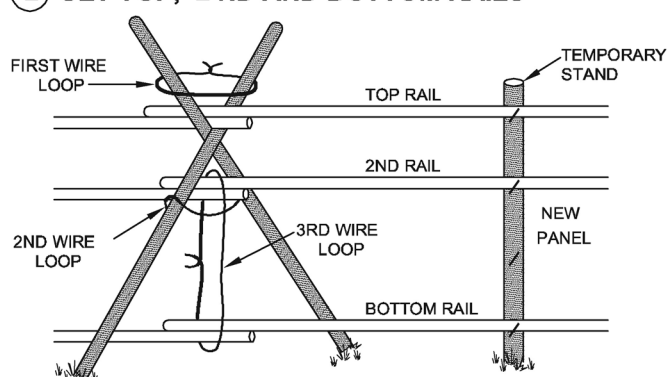


A SLIDE STAKE POLES ONTO PREVIOUS PANEL



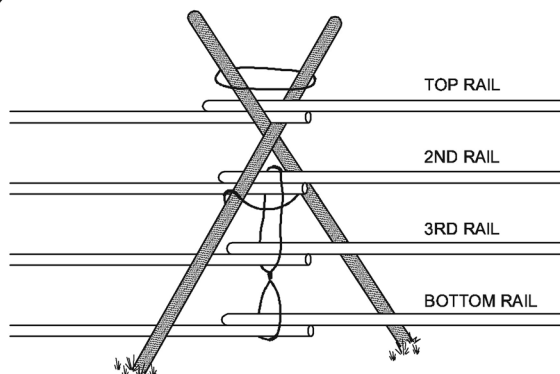
1. 10-12 GAUGE WIRE LOOPS AROUND CROSSED STAKE POLES.
2. SLIDE STAKE POLES ONTO PREVIOUS PANEL AS SHOWN.
3. TOP RAIL SUPPORTED AT CROSS.
4. 2ND RAIL SUPPORTED BY 2ND WIRE LOOP.

B SET TOP, 2ND AND BOTTOM RAILS

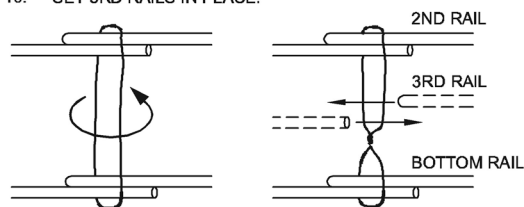


5. SET 3RD WIRE LOOP AND PLACE BOTTOM RAIL OF PREVIOUS PANEL.
6. PLACE 3RD RAIL TEMPORARILY ON THE GROUND.
7. MOVE STAND AND SET TOP, 2ND AND BOTTOM RAILS OF NEW PANEL.

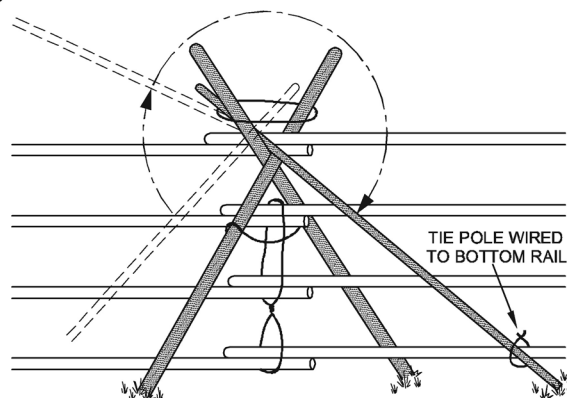
C TWIST 3RD WIRE LOOP AND SET 3RD RAILS



8. 3RD WIRE LOOP MUST BE TWISTED TO SET THE 3RD. RAILS.
9. TWIST AT THE DESIRED HEIGHT OF THE 3RD RAILS WITH 4 TO 5 TURNS.
10. SET 3RD RAILS IN PLACE.



D TWIST TIE POLES IN PLACE



11. INSERT A TIE POLE INTO THE 1ST WIRE LOOP AND ROTATE AS SHOWN TO TIGHTEN THE ASSEMBLY.
12. TIE POLE SHOULD REACH MID PANEL WHERE IT IS WIRED TO THE BOTTOM RAIL ONLY.
13. LASTLY, THE SECOND TIE POLE (NOT SHOWN) IS ALSO INSERTED AND TWISTED IN THE OPPOSITE DIRECTION TO THE OTHER SIDE AND WIRED TO THE BOTTOM RAIL.

NOTE

RUSSELL FENCE CONSTRUCTION REQUIRES EXPERIENCE TO PROPERLY SET WIRE LOOP SIZE AND TO SET THE TIE POLES.

SOURCE: C. ARMES
B.C. FOREST SERVICE

Figure 3

Russell Fence Construction

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BRACE ASSEMBLIES FOR WIRE FENCES

What They Are - How They Work - How To Construct Them

When constructing wire fences, brace assemblies are required to anchor the wire. They are designed to be able to resist the loads that are transferred from the tensioned fence wires and are constructed on-site using fence posts and fence wire. This factsheet outlines background information to help understand fence braces.

Refer to Factsheet 307.220-2 *Brace Assemblies for Wire Fences – End, Inline and Change-of-Direction Braces* for details on types of braces and selecting braces to use for fence conditions.

FUNCTION AND DESIGN OF BRACES

Corner, end and inline brace assemblies are the foundation of a good fence. The failure of one such assembly may result in the failure of a whole section of fence. Particular attention must be given to details such as location in suitable soils, depth of post placement, connection of the rail to the posts and tying off of the wires.

What is a Brace ?

A brace is a made-on-site anchor assembly consisting of one or more posts driven into the ground connected with one or more rails and tensioned together with wire. It forms the tie off point for the fence wire. It is named for the number of driven posts it requires, i.e. a two-post brace has two posts driven into the ground (and is completed with a rail and tensioned brace wire).

What is a brace really doing ?

As a brace assembly is an anchor point it must withstand all the load from the fence wires. Under normal conditions, the tensioned fence wires will exert a pull on the brace of 1,000 to 1,500 lb. With cold weather contraction the pull may be as much as 2,500 lb. In addition, shock loads to the wires, such as from livestock pushing or fallen trees, also have to be withstood.

In barbed wire fences, some of the load is absorbed by line posts when the barbs catch at staples. In smooth wire fences, with line wires not stapled “home”, the total fence load is transmitted to the brace assembly.

A brace must withstand the fence loads by transferring them to the earth. This means a brace is a combination of **structure and soil** - both are important for an effective brace. A brace can fail in one or more ways, by:

- structure failure (broken post or rail)
- soil failure (soil shear in front of the post allowing the post to move)
- end post pull out (indicating poor brace design for the soil conditions)

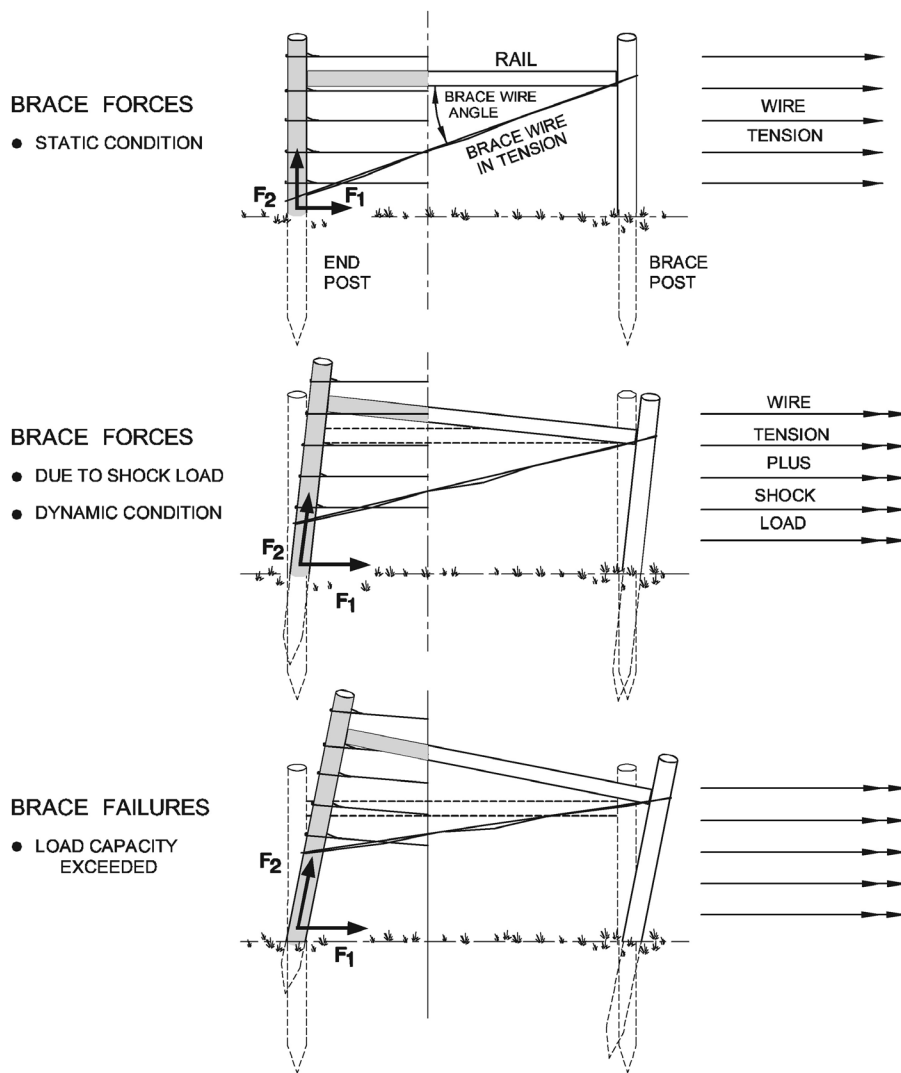


Figure 1 Forces in a End Brace Assembly

What are the forces in a brace ?

Figure 1, above, illustrates the forces on a typical two-post, horizontal rail end brace. It can be seen that the fence wire tension load tends to bend the end post slightly, which, through the rigid rail, also bends the brace post. Movement of the top of the brace post adds tension to the brace wire, transferring part of the load back to the bottom of the end post.

The effect on the end post of this load transfer is in relation to the angle of the brace wire. This transferred load can be broken down into:

- a horizontal force F_1 trying to move the end post through the soil
- a vertical force F_2 trying to pull the end post out of the soil

The “steeper” the angle of the brace wire, the greater this vertical pull-out force. This is why short span braces (with “steeply” angled brace wire) may fail at low fence loads by end post pullout. Longer span braces (with “lower” angled brace wire) apply more horizontal load to the soil and post, failing at higher loads. Longer span braces will use the full load bearing capacities of both the soil and the post. This added strength can also be achieved by lowering the horizontal rail and therefore the brace wire angle.

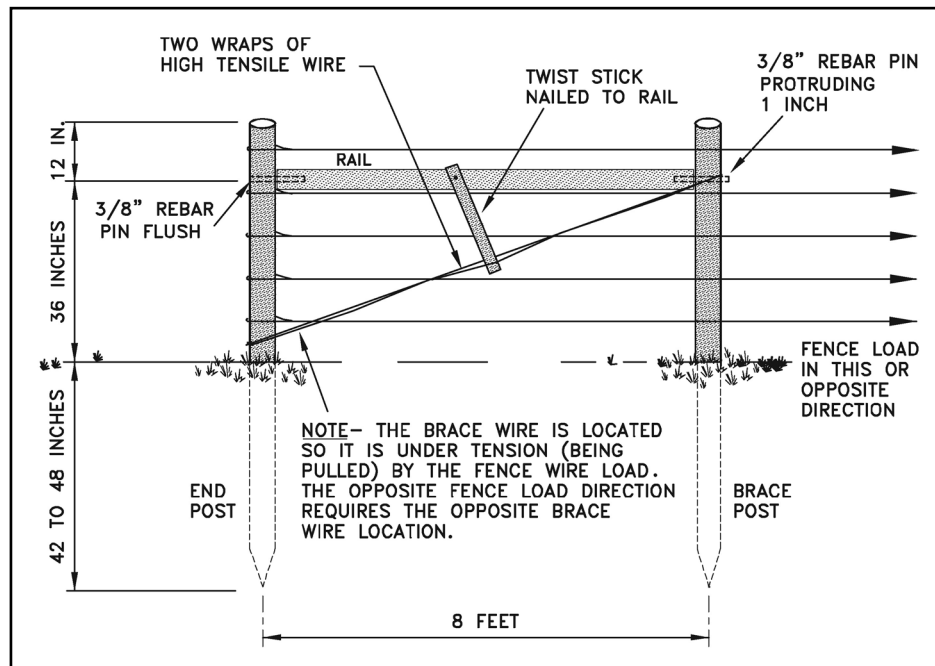


Figure 2 Typical Two-Post Brace Assembly

What size should a brace be ?

Short and long as used in the previous discussion are relative terms. As a rule, a brace should be 2 ½ times as long (between each driven post) as the height of the fence (if the rail is located at fence height). Therefore, for example, a fence brace should be ten feet long for a four foot fence height.

To avoid having to use a ten foot rail, use a shorter rail, set lower between the brace posts. A rule-of-thumb is to use a rail 2 times the fence height, set at ¾'s of the fence height. The example brace is then eight feet long and the rail at three feet from the ground on four-foot high brace posts. This uses economical common sized posts to achieve full strength. This is considered the standard brace portions and is shown in Figure 2, above.

Where to locate a brace ?

A brace is required wherever an anchoring point for the fence wires is needed. Some of these points are dictated by the terrain (dips, rises, etc.) or things like gates. Otherwise, braces are installed at the appropriate wire tie-off distances (660 ft. for barbed or woven wire - 1320 ft. for smooth wire).

What types of braces are used ?

A wide variety of brace designs have been used. Table 1 illustrates designs that have been proven effective. To be effective in resisting fence loads, these designs must be properly constructed and installed in suitable soils.

All the designs have a tie off post (shown larger) that is braced in front, in rear or in both directions to resist movement. Other designs not shown may have the required strength but generally are either too costly, too difficult to construct or both.

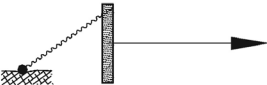
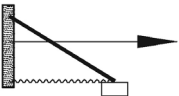
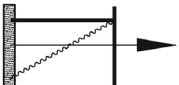
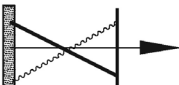
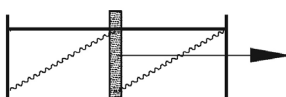
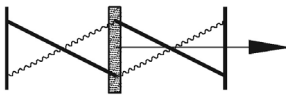
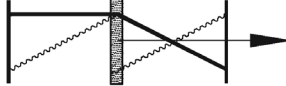
Tests conducted by various researchers indicate that two-post brace assemblies under favorable soil conditions are capable of withstanding loads from 3000–6000 lb. of pull; whereas, three-posts assemblies are capable of almost double that capacity. In good soil conditions, a two-post brace assembly will be adequate for fences of 6 line wires or less.

In soils of low cohesive properties, such as sandy, very wet plastic clays or peats, or when using more than 6 line wires, three-post brace assemblies are used.

Refer to Factsheet 307.220-2 ***Brace Assemblies for Wire Fences – End, Inline and Change-of-Direction Braces*** for details of the braces in Table 1.

Table 1

STANDARD END BRACE ASSEMBLIES(See brace details in Factsheet 307.220-2 *Brace Assemblies for Wire Fences – End, Inline and Change-of-Direction Braces*)

Type of Brace	Diagram	Comments	Page (of Factsheet #307.220-2)
Single-post		For 1–3 low tension wires, i.e., electric fences.	page 1
Single-post, deadman anchor		Requires suitable anchor. Simple with good load rating. Possibly equal to double span with suitable soil and deadman anchor.	page 3
Single-post, diagonal brace (“Kiwi” brace)		Diagonal must be able to move freely on slider.	page 4
Two-post, horizontal rail		Standard for 6 wires or less. Easy to construct properly.	page 5
Two-post, diagonal rail		For 6 wires or less. Requires good rail-to-post connections.	page 6
Three-post, horizontal rails		Standard for over 6 wires or poor soils. Pull from centre.	page 7 - 8
Three-post, diagonal rails		For over 6 wires or poor soils. Requires good rail-to-post connections. Pull from centre.	pages 8 - 9
Three-post, mixed rails		For over 6 wires or poor soils. Requires good rail-to-post connections. Pull from centre.	page 9

↑
ALL FENCE WIRES ARE TIED OFF ON THIS POST

Where to tie off on a brace ?

Normally, the fence wires are tied off on the end post when two-post assemblies are used. To achieve optimum strength using three-post assemblies, line wires are tied off at the **centre post** and the rear panel is "slack" wired. This is to prevent any misalignment of the three driven posts from causing brace failure. Pulling from the center post of a two-post brace can actually re-align the posts whereas pulling from the rear post will cause buckling and failure. Table 1, page 4, indicates proper wire tie off locations.

What are the factors in brace rigidity ?

Some factors effecting the rigidity of a brace (in similar soil conditions):

- the deeper the post is set into the ground, the greater the load capacity
- the larger the diameter of the post the greater the load capacity
- a post driven into undisturbed soil has a greater load capacity than one placed in an over-sized hole and filled by ramming
- dry and clay type soils generally have more resistance than wet and sandy soils

A properly built three-post brace assembly has a greater load capacity than a two-post assembly, but is generally only required in poor soil conditions.

When are double brace wires used ?

Some braces, such as inline braces located in straight fence runs, anchor wires that pull in two directions. In these cases a diagonal tension wire is installed on the brace to resist each load. It is important that these two diagonals are allowed to function separately and they **must not** be wrapped together where they cross each other.

This type of brace will also be located at the hinge post side of a gate opening where the end brace assembly is anchoring the fence wire loads in one direction and supporting the weight of the gate in the other direction. The end brace assembly on the gate latch side will only be anchoring the fence wire loads and therefore require only one diagonal tension wire.

What are good construction methods and materials ?

The importance of proper construction of brace assemblies cannot be overstressed. Posts must be properly sized and must be driven into the ground to the full depth required (i.e. 3½ to 4 feet for most end posts). The driven posts must be in line with the fence as a small off-centre pull will tend to collapse the whole assembly. End or corner posts should lean away from the line of pull (up to 2 in from vertical).

As a rule-of-thumb for most fences, brace posts and rails are one diameter size larger than fence line posts. Fences that may have very heavy loading require brace posts two sizes larger (i.e. for confined areas such as pens or fences for large animals such as bison). The driven posts should be treated to resist rot but the brace rails do not normally require protection.

Standard high tensile steel wire is preferred for the brace wires as it has adequate strength. Two complete wraps are required. For fences with four strands or less, two wraps of a low tensile steel wire (such as most barbed wire) will suffice, but this brace wire will likely be a weak point. Fences that are expected to be 'tested' by livestock or windfalls should be constructed with superior braces. All brace wires should have Class 1 galvanization; Class 3 is preferred, especially in wet and coast locations.

Braces constructed with the 'drill & pin' method use steel rebar pins. Galvanized pins are unlikely required except in the very wettest environments.

Wooden brace 'twist sticks' should be a minimum 1.5 inch x 1.5 inch cross sectional size. They should be attached to the brace rail (a nail will do) to prevent accidental unwinding. If attached, the stick need not extend up past the brace rail and therefore will present no danger to livestock or wildlife that may attempt to jump the brace.

How to build a horizontal rail brace

While there are many possible brace designs, the horizontal rail brace is the most often used design. It provides the required strength in an easy to construct, economical layout.

This brace may be constructed as either a two-post brace (for normal soil and fence conditions), or a three-post brace (for poor soil or high fence load conditions). The two-post, horizontal rail is the standard brace for fences of 6 wires or less in suitable soils.

Construction steps for a two-post, horizontal rail, end brace

Two driven posts are connected by a rail and tensioned together by a brace wire. The rail-to-post connections are drilled (to prevent splitting) and pinned or nailed. Two diagonal wraps of 12 ½ ga high tensile smooth wire complete the brace giving it the required strength while maintaining flexibility under shock loads (such as falling trees).

Construction sequence is as follows (see Figure 2, page 3):

- drive the end post with a 2 inch lean away from the fence load
- drive the brace post spaced twice the fence height from the end post
- mark the drill holes on both posts at approximately $\frac{3}{4}$ fence height from the ground (i.e. 3 ft on a 4 ft fence)
- drill a $\frac{3}{8}$ inch diameter hole through each post in line with the fence
- cut the rail length to fit snug at this $\frac{3}{4}$ point
- drill a $\frac{3}{8}$ inch diameter hole 3 inches deep in the center at each end
- place the rail in position lining up the drilled holes
- drive a $\frac{3}{8}$ inch rebar pin through the posts and into each end of the rail
- leave 1 inch of pin protruding from the brace post; drive the pin flush in the end post
- drive a staple into the base of the end post about 4 inches from the ground
- hook one end of the brace wire onto the protruding brace post pin
- wrap two full turns around the staple and the pin
- pull all slack out of the brace wire
- hook the remaining end of brace wire around the pin
- staple off both ends of the brace wire
- twist the brace wire using a twist stick to remove the wire slack
- secure the twist stick to the rail (nail or wire on)
- attach the line wires

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Fencing FACTSHEET

BRACE ASSEMBLIES FOR WIRE FENCES

End, Inline and Change-of-Direction Braces

This factsheet outlines brace construction for wire fences, ranging from single post to multiple post braces. For explanation of brace function, sizing and how braces fail refer to Factsheet 307.220-1 *Brace Assemblies for Wire Fences – What They Are – How They Work – How to Construct Them*.

TYPES OF BRACES

Refer to Table 1, page 2, for an outline of the types of braces being discussed. They include single-post, two-post and three-post styles with horizontal and diagonal rails, for end and inline requirements.

SINGLE-POST BRACES

These braces are the simplest and least expensive but are generally used for only the lowest fence loading conditions. They should be constructed in firm soil. There are three basic types all using a post diameter size one larger than the line posts.

Basic Single-Post Brace

A wooden post driven 3-1/2 to 4 feet in firm soil can be used as an end post. One to three wires can be tied off at this post. These wires should only be low tensioned wires such as in an electric fence. Because it lacks any bracing the single post relies only on post-to-soil friction. Effectiveness can be increased by burying a 2 foot long block of wood (pressure treated) just below ground level at right angles to the pull of the fence wires to act as a thrust block. Refer to Figure 1, below. This design is suitable for an end brace but not generally for a corner brace. (Refer to Factsheet 307.600-1 *Wire Fence Construction* for using single posts as “braces” when fencing around corners)

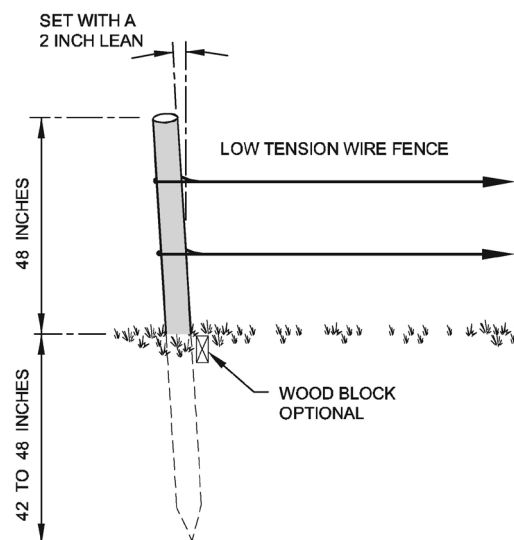
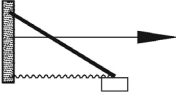
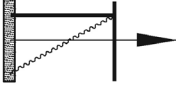
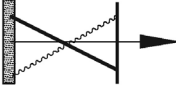
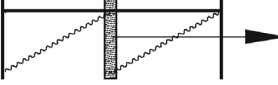
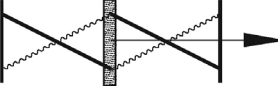


Figure 1

Single-Post Brace

Table 1

STANDARD END BRACE ASSEMBLIES(See brace details in Factsheet 307.220-2 *Brace Assemblies for Wire Fences – End, Inline and Change-of-Direction Braces*)

Type of Brace	Diagram	Comments	Page of this Factsheet
Single-post		For 1–3 low tension wires, i.e., electric fences.	page 1
Single-post, deadman anchor		Requires suitable anchor. Simple with good load rating. Possibly equal to double span with suitable soil and deadman anchor.	page 3
Single-post, diagonal brace (“Kiwi” brace)		Diagonal must be able to move freely on slider.	page 4
Two-post, horizontal rail		Standard for 6 wires or less. Easy to construct properly.	page 5
Two-post, diagonal rail		For 6 wires or less. Requires good rail-to-post connections.	page 6
Three-post, horizontal rails		Standard for over 6 wires or poor soils. Pull from centre.	page 7 - 8
Three-post, diagonal rails		For over 6 wires or poor soils. Requires good rail-to-post connections. Pull from centre.	pages 8 - 9
Three-post, mixed rails		For over 6 wires or poor soils. Requires good rail-to-post connections. Pull from centre.	page 9

**ALL FENCE WIRES ARE TIED OFF ON THIS POST**

Single-Post, Deadman Anchor Brace

Adding a deadman anchor to the single post increases the load rating (Figure 2, below). Buried steel or wood anchors or steel screw-type anchors are used. Firm soil is required for best results. Steel “foot and cable” anchors are available that are driven into the ground then pulled to set the foot. Screw-type anchors (manual or machine assisted installations) are difficult to install in rocky soil. In light soils, the post may tend to be driven downward by the interaction of the fence and anchor loads. This design can be used as either an end or corner brace. For corners, use two anchors to resist the fence loads of both fence lines.

This design can support loads equal to a double span brace with suitable soils and deadman anchors.

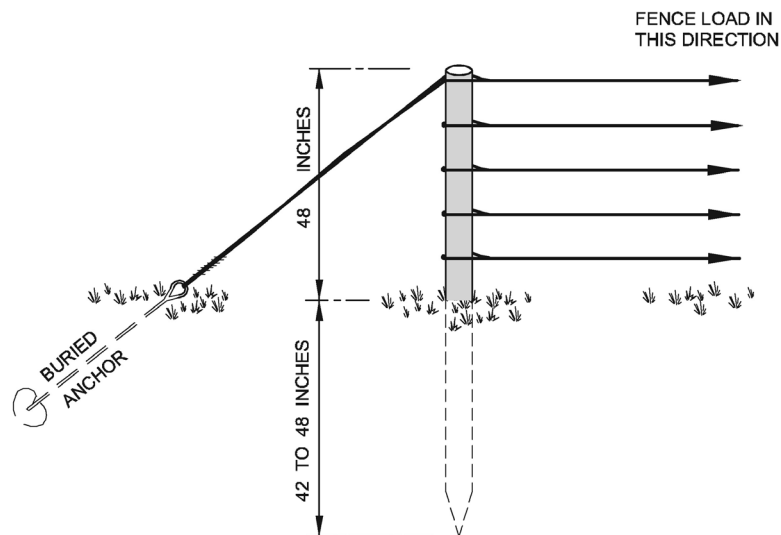


Figure 2 **Single-Post, Deadman Anchor Brace**

Single-Post, Kiwi Brace

The third single driven post brace design is one termed the “Kiwi” brace from its use in New Zealand. It’s both simple and effective with load capacity equal to the single span braces. It is a modification of a diagonally supported post without the tendency for the diagonal to “jack-out” the end post. **It is most important that the lower end of the diagonal rail be allowed to move freely to reduce this “jacking-out” tendency.** A slider block is used for this as shown in Figure 3, page 4.

Two versions are used; one with a steel rod for a lower member and one with two wraps of htsw fence wire. Both are effective; the rod is likely more expensive but will resist side-to-side movement better. In either case a slider is used that will allow free movement of the diagonal in response to fence loads. Note that side to side movement of this rail is **not** desirable and a short stake may be required on either side of the lower end of the rail.

The lower tension member (rod or wire) should not be over tightened, only enough to remove any slack. The two wraps of htsw do not need to be twisted together. Once the fence wires are tied off to the brace and tensioned, the brace will “set”.

This design is suitable as an end and inside brace. When constructed as a corner brace, two diagonal braces and tension wires are used to resist the fence load in the two directions.

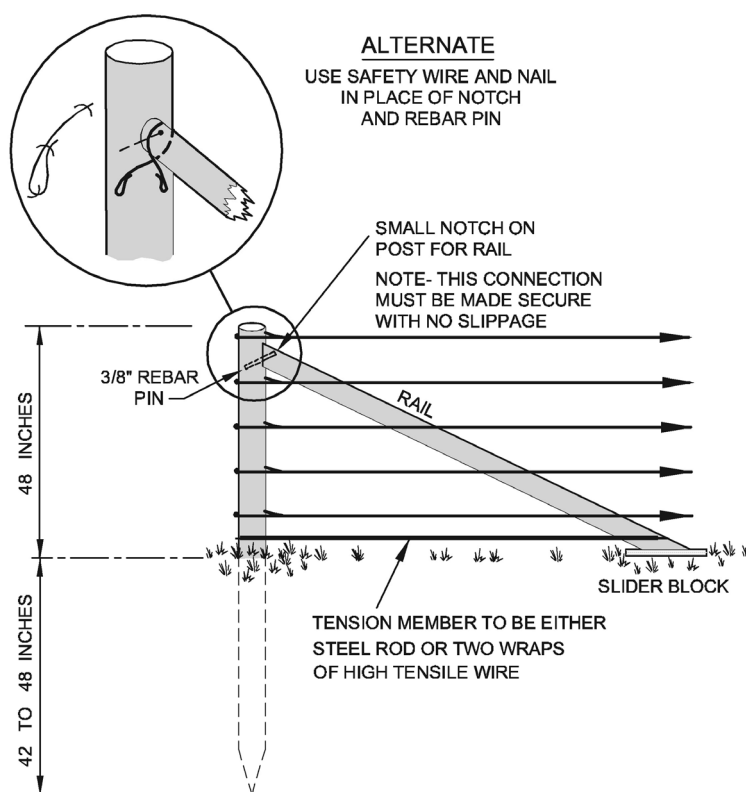


Figure 3 Single-Post, "Kiwi" Brace

TWO-POST BRACES

These are the most commonly used braces and are built using either a horizontal or diagonal rail. Where soil conditions are suitable (firm, not sandy) they can be used in virtually all livestock fences. Generally the driven posts are one diameter size larger than the line posts and the rail the same diameter size as the line posts. They are simple to construct and effective if the following points are considered.

Two-Post Brace Recommendation

The two types of two post braces (horizontal rail - page 5 and diagonal rail - page 6) can be considered to have very similar load capacities (in similar soils). However, the construction of the diagonal brace **requires good connection of the rail ends to each post**. These take more time and poor joints will allow movement and encourage failures. As well, the horizontal rail design can be loaded in both directions (as an inline brace) simply by locating the brace wire(s) in the correct direction. The diagonal rail design can only be loaded in one direction (reverse loading will cause the brace wire to slacken).

It is for these reasons that the easier-to-construct horizontal rail design is usually recommended and the most often built brace assembly.

Two-Post, Horizontal Rail, End Brace

This is the standard design for fences of 6 wires or less in suitable soils (Figure 4, below). The construction sequence is given below.

This brace can be used as an inline brace where long runs of straight fence have no corners for tie off. In this case, fence wires will be pulling from **two directions** (not one as in an end brace) so **two brace wires** are required. The brace wires should be free to move independently, **not** twisted together. Note that double span braces are often used as inline braces because of their added strength (Figure 7, page 8 and in Figure 9, page 9).

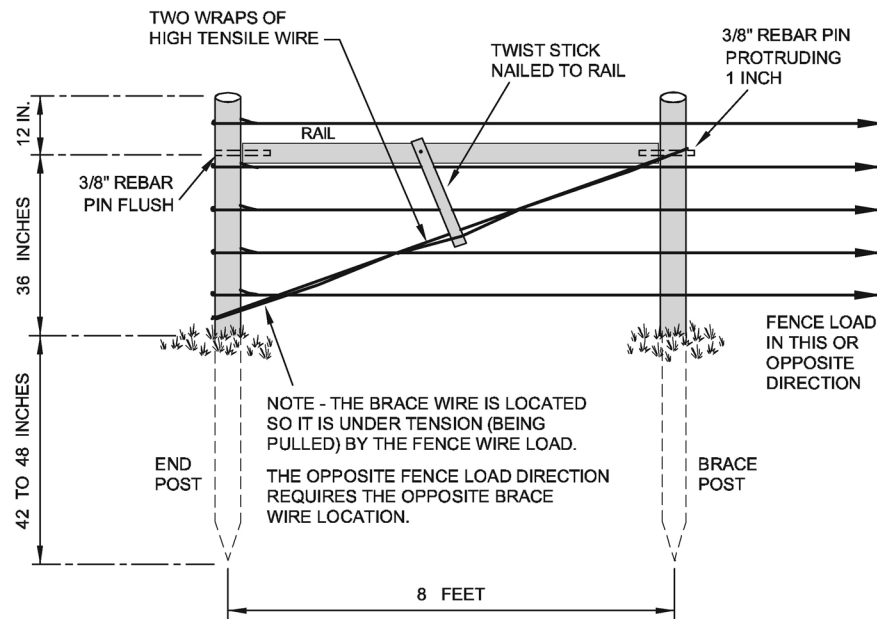


Figure 4 Two-Post, Horizontal Rail, End Brace

Two-Post Brace Construction

Two driven posts are connected by a rail and tensioned together by a brace wire. The rail-to-post connections are drilled (to prevent splitting) and pinned or nailed. Two diagonal wraps of 12 ½ ga high tensile smooth wire complete the brace giving it the required strength while maintaining flexibility under shock loads (i.e. falling trees).

The two-post, horizontal rail is the standard brace for fences of 6 wires or less in suitable soils. Construction steps are:

- drive the end post with a 2 inch lean away from the fence load
- drive the brace post spaced twice the fence height from the end post
- mark the drill holes on both posts at approximately ¾ fence height from the ground (i.e. 3 ft on a 4 ft fence)
- drill a 3/8 inch diameter hole through each post in line with the fence
- cut the rail length to fit snug at this ¾ point
- drill a 3/8 inch diameter hole 3 inches deep in the center at each end
- place the rail in position lining up the drilled holes
- drive a 3/8 inch rebar pin through the posts and into each end of the rail
- leave pin protruding 1 inch from the brace post; drive pin flush in the end post
- drive a staple into the base of the end post about 4 inches from the ground
- bend the end of the brace wire into a “U” shape and hook onto the protruding brace post pin

- wrap two full turns around the staple and the pin
- pull all slack out of the brace wire
- hook the remaining end of brace wire around the pin
- staple off both hooked ends of the brace wire
- twist the brace wire using a twist stick to remove the wire slack
- secure the twist stick to the rail (nail or wire on)
- attach the line wires

Two-Post, Diagonal Rail, End Brace

This design is very similar to the previous except the rigid rail is placed diagonally instead of horizontally between the two driven posts (Figure 5, below). When loaded by the fence wires, this brace reacts as a horizontal rail brace except the diagonal rail applies its load to the bottom of the brace post rather than the top. The brace wire is under tension as the brace post is moved in the direction of the load. Good connection of the rail to the post is important to prevent the diagonal rail from slipping under load.

This brace tends to have less end post movement in the direction of the load (compared to the horizontal rail brace) but has a greater uplifting force on the end post. Deeper placement of this end post is recommended for all diagonal braces.

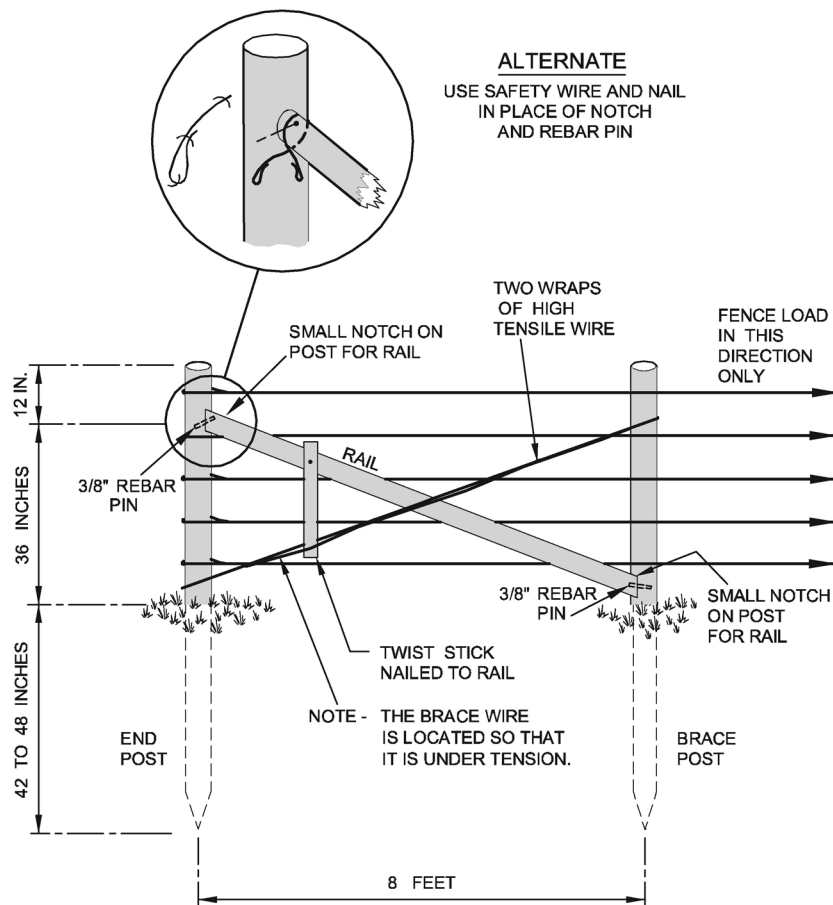


Figure 5 Two-Post, Diagonal Rail, End Brace

THREE-POST BRACES

When either fence loads or soil conditions require increased brace strength, a two-post brace is expanded by using three driven posts. Because of the difficulty in driving these three posts in direct line with the pull of the fence wires, **three-post braces can fail prematurely if the incorrect tie off point for the fence wires is used.**

Looking at Table 1, page 2, it can be seen that a three-post brace is really just a two-post brace with additional rear bracing. The tie off point is clear: it is the **centre post**. Three end brace designs are traditionally used; double horizontal rail, double diagonal rail or mixed rail. The double horizontal rail brace can also be used as an inline brace when the extra brace wires are added. Other (non-traditional) three-post braces are also possible. These mainly combine a single span brace with additional support from a deadman anchor or the kiwi brace.

As for two-post braces, three-post braces generally have brace posts are one diameter size larger than line posts and the rails the same diameter size as line posts.

Three-Post, Horizontal Rail, End Brace

This is the standard design for fences of more than six wires or in poor soil conditions. Three driven posts are connected by two rails and two brace wires as in Figure 6. The construction sequence is similar to the two-post sequence on page 5:

- drive the end post, preferably with a 2 inch lean away from the fence load
- drive the center post, preferably with a 1 inch lean away from the fence load
- drive the brace post
- space these three posts using the 2:1 minimum distance rule between **each** post
- drill the posts and rails and pin together
- leave 1 inch of pin protruding from the brace post
- wire both panels with the brace wires
- fence line wires will be tied off at the center post
- “slack” wire the rear panel

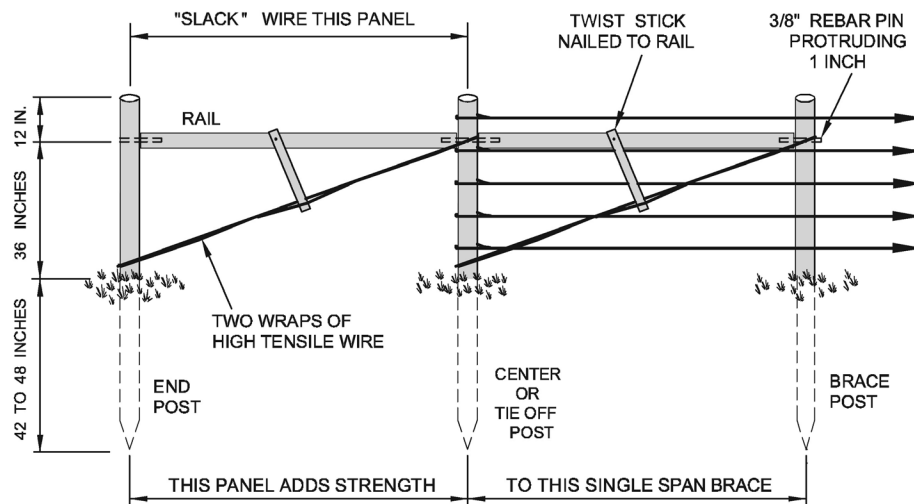


Figure 6 Three-Post, Horizontal Rail, End Brace

Three-Post, Horizontal Rail, Inline Brace

As with two-post, horizontal rail braces, this three-post brace can also be used as an inline brace (Figure 7, below). Fence wires from two directions will be tied off at the center post. To resist this loading, brace wires must be installed in both panels, in both directions, forming two "X"s. As with the two-post brace, these must be free to move independently, **not** twisted together.

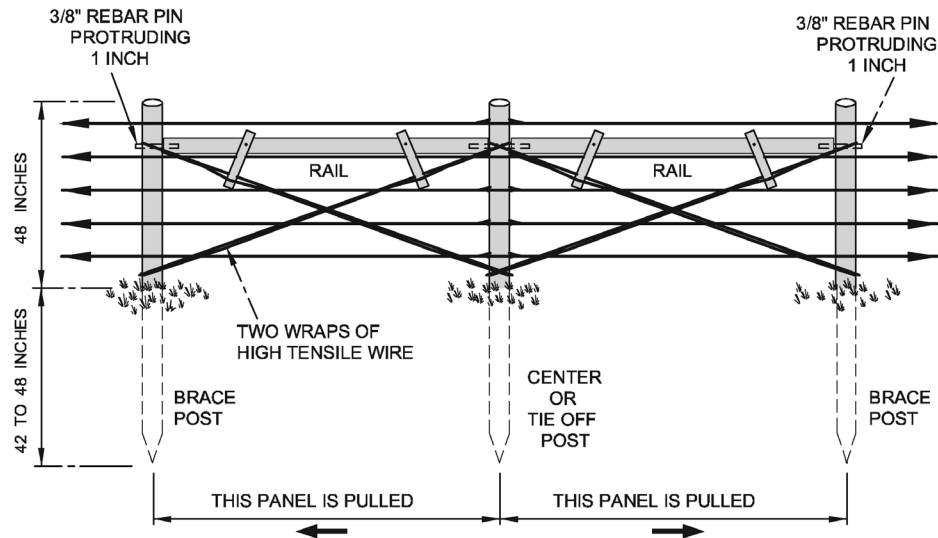


Figure 7 Three-Post, Horizontal Rail, Inline Brace

Three-Post, Diagonal Rail, End Brace

This design is very similar to the previous except the rigid rails are placed diagonally instead of horizontally between the three driven posts (Figure 8, below). Brace strength is approximately equal in both. The same points discussed on page 4 regarding two-post horizontal versus diagonal braces applies to three-post braces as well; diagonal rails are more difficult to install correctly and can be loaded in one direction only (and can only be used as an inline brace as shown in Figure 9, page 9).

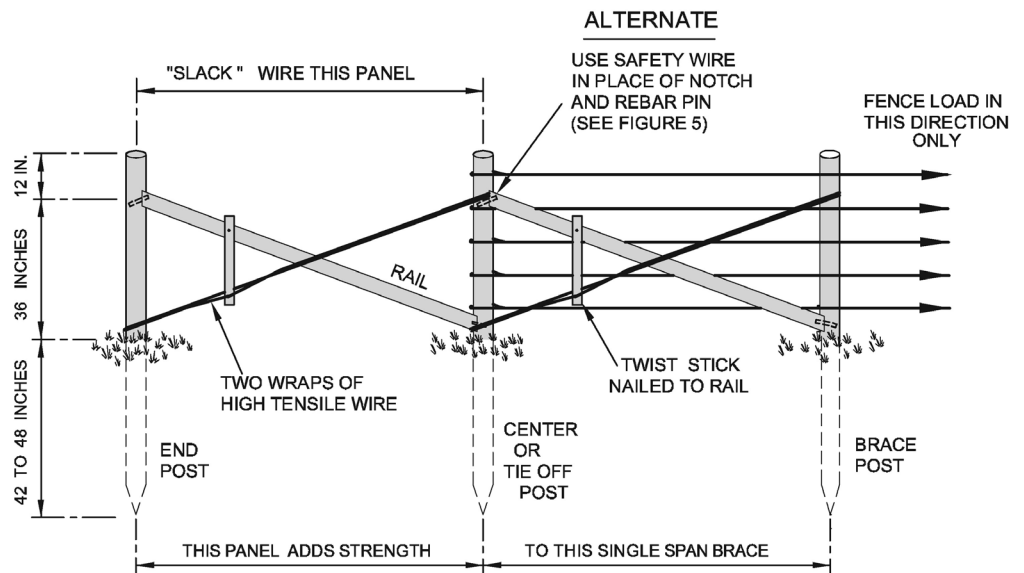


Figure 8 Three-Post, Diagonal Rail, End Brace

Three-Post, Diagonal Rail, "Inline" Brace

This is actually not a true three-post brace (as only the brace strength of a two-post brace is supporting either fence wire load) but rather two, two-post braces sharing an end post (Figure 9, below). Brace strength in either direction is **not equal to other double span braces**. This design is not normally recommended because for about the same materials and effort a three-post - horizontal rail inline brace has greater strength.

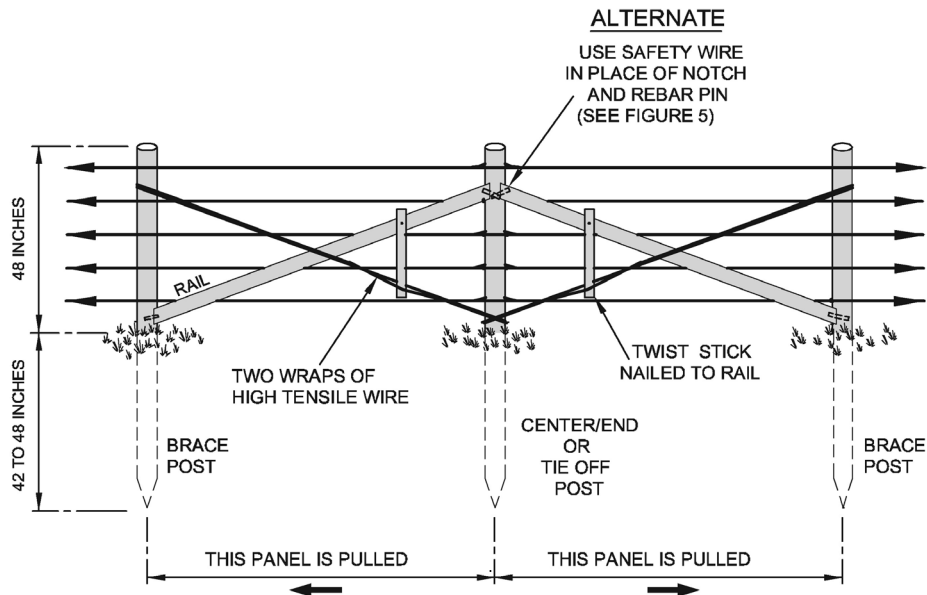


Figure 9 Three-Post, Diagonal Rail, Inline Brace

Three-Post, Mixed Rail, End Brace

This design is a mixture of the previous three-post braces. The center post is still the tie off location. The forward section has a diagonal rail and the rear section has a horizontal rail (Figure 10, below). Disadvantages are once again construction difficulty and one direction loading. This brace has strength equal to the previous three-post braces discussed.

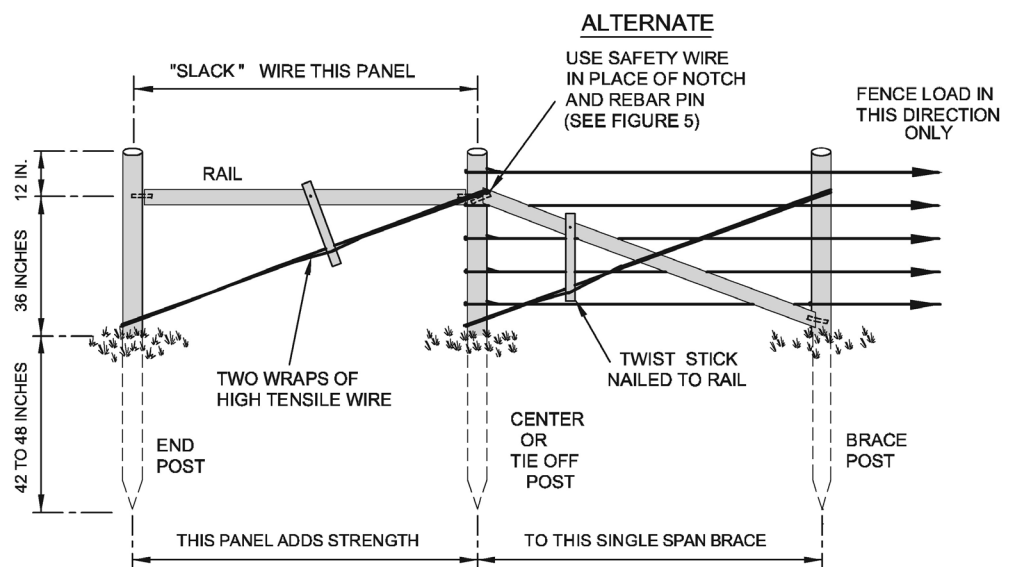


Figure 10 Three-Post, Mixed Rail, End Brace

CHANGE OF DIRECTION BRACES

The previous braces have been at either [the end](#) of the fence or along a straight line section. Those braces had loads applied **directly in line** with the brace as outlined in Factsheet 307.220-1 *Brace Assemblies for Wire Fences – What They Are – How They Work – How to Construct Them*.

A change of direction, however, produces reactive forces that are not inline with the brace that can cause leaning or complete brace failure. This is commonly seen at fence “dog legs.” The amount of force is proportional to the degree of angle change and acts through the center of the corner (Figure 11, below). Although a small change of direction produces a small force, a standard brace is not usually able to resist it. At a 90° corner, the brace is better able to resist it due to the alignment of brace members.

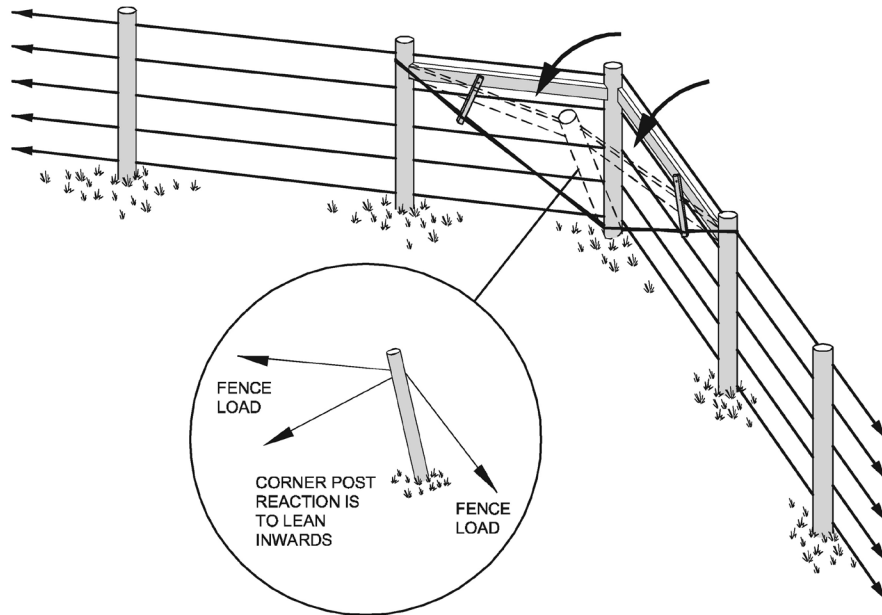


Figure 11 Forces in a Brace Assembly at Changes of Direction

The post at the change of direction must be supported and, although the loads are similar, different solutions are available for different situations. In the following discussions, the angle of change of fence direction is:

- defined as the angle between the line of sight of one fence to the other fence line
- can be estimated by the measurements given in Figure 12, below

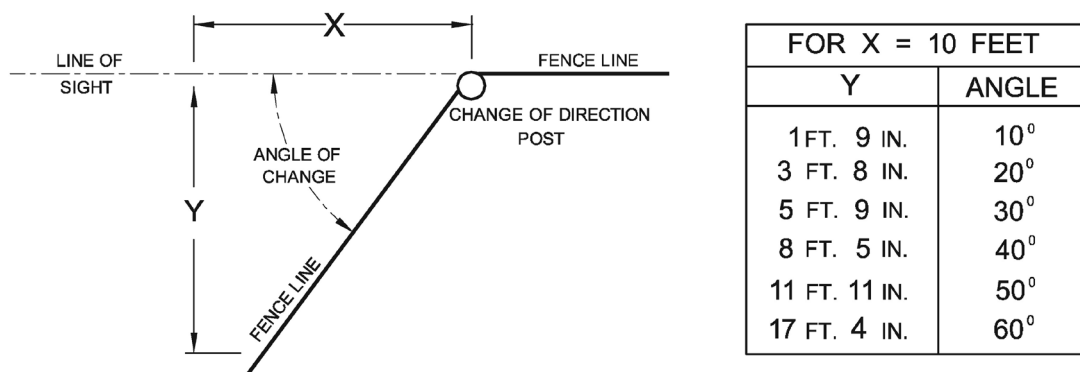


Figure 12 Estimating Fence Line Angle of Change

**Change of
Direction:
At Tie Off
Points**

If it's appropriate to tie the fence wires off a **separate** end brace can be constructed for each fence section as in Figure 13 below. Rather than 'share' a common tie off post, each section is tied off to a separate end post producing no forces out of line with the braces. This requires an extra driven post per corner and 'slack' wiring the opening between posts but ensures a stable corner.

- for corners less than 60° use either separate corner posts, Figure 13, or brace the corner post, Figure 15
- for 60° to 90° corners use a standard shared-post corner brace as in Figure 14

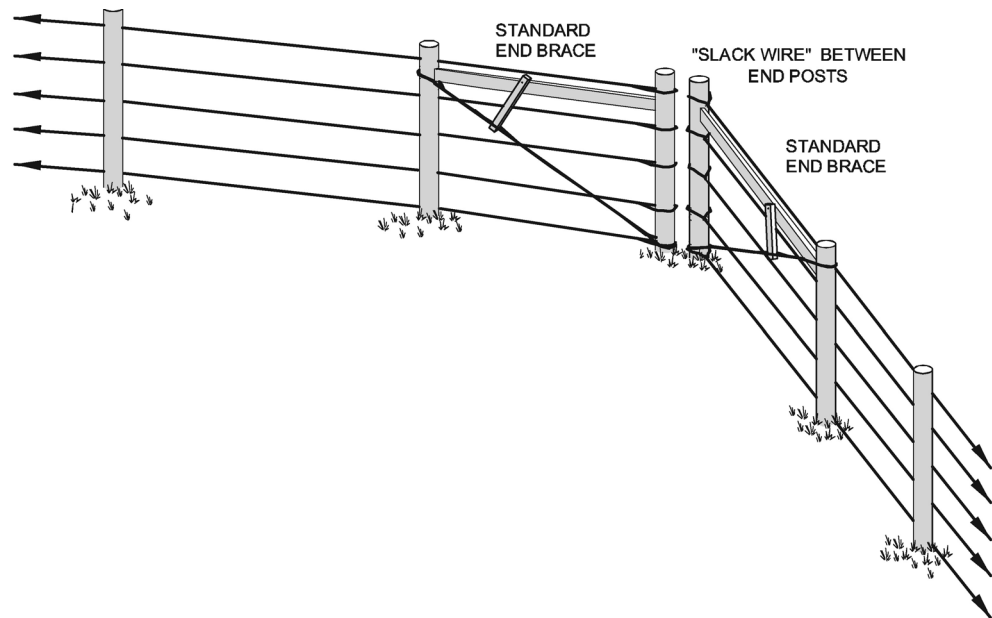


Figure 13 Separate Braces at a Tie-Off Corner (changes less than 60°)

For changes of fence direction from 60° to 90° , a normal shared-post corner will be effective (Figure 14, below). This brace can be used at a tie off corner or used between tie points with the fence wires continuous around the brace (in this case special stapling techniques are used to reduce wire-to-post friction around the corner post ensuring flexibility of the wires when loaded; refer to Factsheet 307.100-2 **Fence Wire: - Dispensing, Stapling, Joining, Tying, Tensioning and Grounding**).

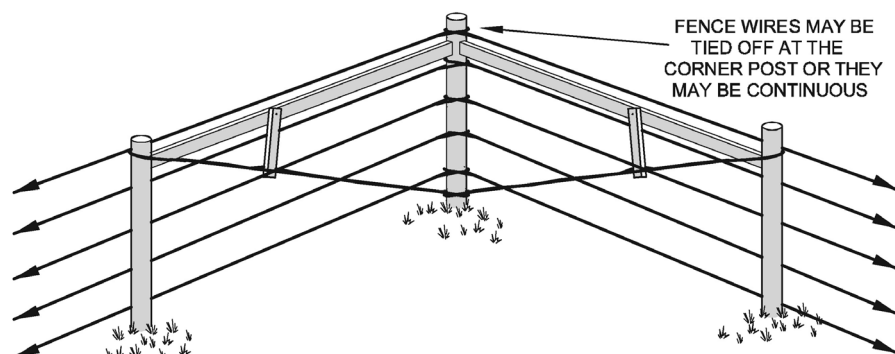


Figure 14 Shared-Post Brace at a Corner (for changes greater then 60°)

**Change of
Direction:
Between
Tie Off Points**

Often the fence change of direction occurs when it is not appropriate to tie off the fence wires (i.e. less than the 660 feet or 1320 feet rule for tensioning wire). Rather than have many short sections of fence, the wires can continue around the change of direction post provided the post can be adequately supported and special stapling methods are used. Figure 15, below, illustrates three possible braces. Refer to Factsheet 307.100-2 **Fence Wire: - Dispensing, Stapling, Joining, Tying, Tensioning and Grounding** for wire tie-off distances and special stapling methods.

For changes of direction greater than 60° use the brace in Figure 14, previous page.

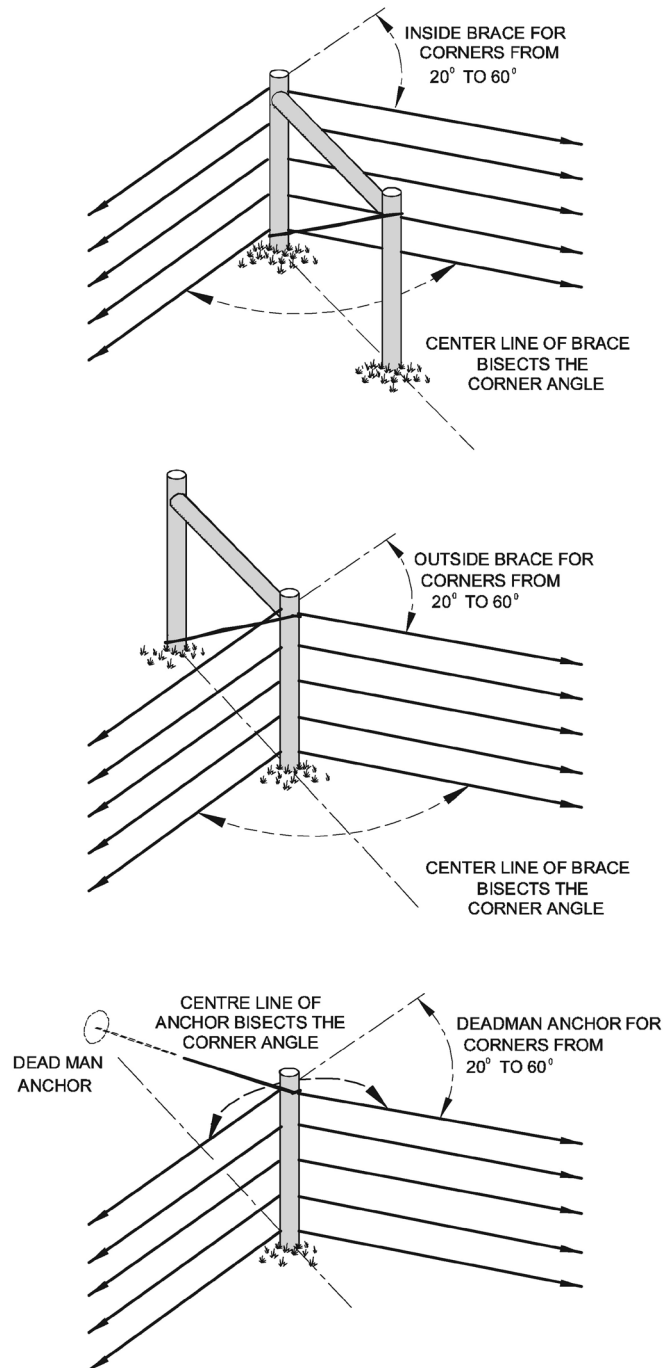


Figure 15 Change of Direction Braces (for changes less than 60°)

FOR FURTHER INFORMATION CONTACT

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LIVESTOCK CONTROL NON-ELECTRIC FENCE DESIGNS

Introduction

A wire fence design refers to the physical description and spacings of the wire, line post and dropper components for a particular fence. The following specifications are typically required for an electric wire fence:

- description of wire
- number of wires
- wire spacings (from the ground)
- post spacing
- dropper spacing (if used)

These specifications must be chosen taking into account the various planning points, the three main ones being fence purpose, type of animal and site conditions. The other details of the fence such as post size, brace design, dropper type, etc. are set by construction practice once the above specifications have been selected.

Four all-wood fence designs and eighteen wire designs are outlined, each having their unique specifications.

NON-ELECTRIC FENCE DESIGNS FOR LIVESTOCK CONTROL

Non-Electric Cattle Fences

The majority of non-electric agricultural fences constructed in B.C. are cattle fences either around hay fields, pastures or rangeland. These fences must control a variety of cattle including range bulls, pasture cows, cows with small calves and large breeds under conditions from native range to irrigated pasture. No one non-electric design is used, however the designs on pages 5 to 15 (or variations thereof) have been proven effective. Exact wire spacings given are not critical in most cases and are often adjusted to suit the particular animal size and behavior.

For Crown range wire fences, the top wire is to be not more than 42 inches and the bottom wire not less than 18 inches from the ground as measured at the post. This is considered the most suitable for cattle while allowing wildlife passage.

Most all-wood fence construction is for corrals and feedlot use or for windbreak situations. Where sufficient material is available along the fence right-of-way, rail fence designs are occasionally used. However, with the increased value of timber, these fences are seldom being built.

For Crown range log fences, the height at the time of construction should not be greater than 54 inches. To allow fawns to move under the fence, use an oversized bottom block (minimum 15 inches) every 1,600 feet. To allow ungulate movement, create a wildlife jump every 1,600 feet by leaving one end of the top log on the ground.

For Crown range Russell fences, the top rail should be no more than 54 inches and the bottom rail at least 18 inches from the ground, measured at the center of the panel at the time of construction. To allow ungulate movement, create a wildlife jump every 1,600 feet by leaving one end of the top rail on the ground.

Non-Electric Sheep Fences

The control of sheep with non-electric fences can be achieved with either individual wire strands (barbed or smooth) or woven wire. Individual strands can be more effective when electrified. Barbed wire may not be suitable for sheep fences because the barbs will pull the fleece.

Non-Electric Horse Fences

Many horse injuries are fence related and may be as a result of fence design, materials, workmanship or combinations of these. While a horse fence may simply be a modified cattle design, the most successful horse fences are designed and built with specific horse habits in mind:

- the tendency to get hooves and legs caught in wires or brace assemblies
- the habit of chewing wooden boards
- the need for good fence visibility

Non-electric horse fences may be all wood, all steel wire, polymer, polyvinyl chloride (PVC) or combinations of these materials. Designs may be for low pressure pastures or high pressure corrals. Barbed wire may be a poor material for some horse fences (i.e., high value animals) and should not be electrified. Self-supporting steel fence panels linked together may be used in high-pressure situations when temporary or movable containment is required.

Chewing of wooden boards may be reduced or stopped by using electrified wires.

Woven wire should be chosen by the size of the openings. Some horses will put their hooves through openings or “walk down” a fence. A diamond weave material, a 2-inch by 4-inch rectangle opening or a polymer grid fabric (all “no climb” materials) can be used in these cases.

Special “estate” type materials are available for horse fencing which offer superior aesthetics and visibility. These include polymer coated steel wire (as a strand or rail), all polymer strand, all polymer grid fabric or polyvinyl chloride (PVC) posts and rails. Some of these are beyond the normal “farm fence.”

Refer to Factsheet No. 307.260-3 entitled ***Pasture Fencing for Horses*** for details of horse fencing and a comparison of various materials used for horse fences.

Non-Electric Game Fences

The *Game Farm Regulation* under the *Animal Health Act* in B.C. identifies bison, reindeer and fallow deer as permitted species that may be farmed. The perimeter fencing must be approved to obtain a game farm licence. This is a unique requirement in B.C. agriculture and recognizes the concern of escapements possibly establishing in the wild. Interior fencing is not regulated.

Bison Fences. Statements such as “Bison will respect any fence they want to” may give fence builders little faith in their work. However, bison are not generally considered to be a problem with fences given good management and sufficient space. Therefore cattle fence designs for medium or greater pressure can be modified for bison grazing areas.

Bison perimeter fencing should be at least 54 inches and may be up to 72 inches high (it is said if bison can get their nose over the fence they will attempt to push through or jump over it). These fences may be 5 to 8 individual strands or woven wire (a 10-strand, 60-inch-high wire is marketed as bison wire).

In bison calving areas, fence designs should be modified to reduce the space between wires for the smaller young animals with the addition of an extra wire strand or two. Bison corral fences are generally constructed much stronger than equivalent cattle corral fences that are shown on page 6. This is in respect for the bison size, strength and quickness as well as their temperament when confined in corrals or alleyways. If bison are confined for feeding (especially if mixed herd animals are together) use a corral grade fence not a low pressure grazing design.

Fallow Deer Fences. Two distinct fence designs are used: perimeter fences (permit design required) and interior fences (at the producers choice). The perimeter fence requirement of the game farm permit is:

- 7 feet total height, all of which must be woven wire
- knotted joint construction (for security)
- 6-inch vertical wire spacing (fawn proof)

All other design details are at the discretion of the producer as long as the ability to contain the deer is maintained. Refer to Factsheet No. 307.271-1 entitled **Deer Farm Perimeter Fence** for design details.

While a 7-foot height is specified, this is for the 'openness' of a woven wire fence. If deer can see a very distinct line at the top of fence (such as a top rail) they can jump 7 feet. Fences constructed of more solid material such as boards (i.e., holding yards at the barn) must be a minimum 8 feet in height, preferably 9 feet. Also, the snow pack should be considered if it may significantly reduce the effective fence height.

Reindeer Fences. Experience with fencing requirements to control reindeer is limited but suggests they are not a jumping deer. However, the initial perimeter fencing of reindeer in B.C. has been to fallow deer standards. This may change in the future with more experience. The small openings in some woven wire game fence will also help repel predators and as such the fence is serving a dual purpose.

Polymer or Plastic Fences

These materials are relatively new to agricultural fencing but offer some unique advantages. For livestock control, the main use has been for horse fencing, especially where aesthetics is important. Some of the more expensive options could be considered “estate” fences.

These materials weather well, can be coloured, offer good visibility, are easy to handle and may require low maintenance. Polymer materials are also used in crop protection and special fences.

Guide to Non-Electric Fence Designs for Livestock Control

Detailed designs and specifications are located on the following pages for the main agricultural non-electric fences as listed below. The designs shown in this Factsheet are on the page numbers given. Other designs are on the factsheets listed.

Table 1 Guide to Non-Electric Fence Designs for Livestock Control								
	All-Wood		Barbed Wire		High Tensile Smooth Wire		Woven Wire	
Cattle	Post & Rail	pg. 5	4-strand	pg. 9	4-strand	pg. 11	Woven	pg.15
	Snake Rail	pg. 6	5-strand	pg. 10	5-strand	pg. 12		
	Log & Block	pg. 7			6-strand	pg. 13		
	Russell	pg. 8			6-&8-strand	pg. 14		
Horses	Post & Rail	pg. 5			6-strand	pg. 16	Woven	pg. 17
	Snake Rail	pg. 6						
	Log & Block	pg. 7						
	Russell	pg. 8						
Sheep					6-strand	pg. 18	Woven	pg. 19
Bison			5-strand	pg. 20	7-strand	pg. 21	Woven	pg.22
Fallow Deer					5-strand	pg.23	Woven-Perimeter (see also details in Factsheet 307.271-1 <i>Deer Farm Perimeter Fence</i>)	pg. 24
							Woven-Interior	pg. 25
Reindeer					5-strand	pg.23	Woven-Perimeter Woven-Interior	pg. 24 pg. 25

Comments on the Following Fence Design Information

The material description of wooden posts indicates a diameter range which is the smallest diameter acceptable (usually the post top). For example '3–4 inch' notation describes a post requiring a minimum (top) diameter between 3 and 4 inches.

The following materials description and the amount of material required per mile of fence are calculated for level terrain. Rough or rolling terrain may require more materials.

Note that the brace materials are based on the basic single span, horizontal brace consisting of two driven posts and one horizontal rail (refer to Factsheet No. 307.220-2 entitled *Brace Assemblies for Wire Fences – End, Inline, and Change-of-Direction Braces*). Braces are spaced up to the maximum recommended tie-off distances for the type of fence wire used (refer to Factsheet No. 307.100-2 entitled *Fence Wire – Dispensing, Stapling, Joining, Tying, Tensioning and Grounding*).

NOTE: The following design information suggests minimum post, rail and brace member sizes, etc. Larger sizes or modifications to the designs may be chosen where the added cost and installation labour is considered worthwhile for improved benefits.

ALL-WOOD FENCE DESIGNS FOR CATTLE OR HORSES

- USE:** cattle, horses;
pasture, corral or feedlot
- RAILS:** 4 boards or 5 round
Rails overlapped joints
- POSTS:** spaced 6 to 12 feet
(depending on rail length)
- HEIGHT:** up to 60 inches
- NOTES** This is the basic
all-wood fence. Used
from pastures to feedlots.
See Factsheet 307.600-2
Wood Fence Construction.

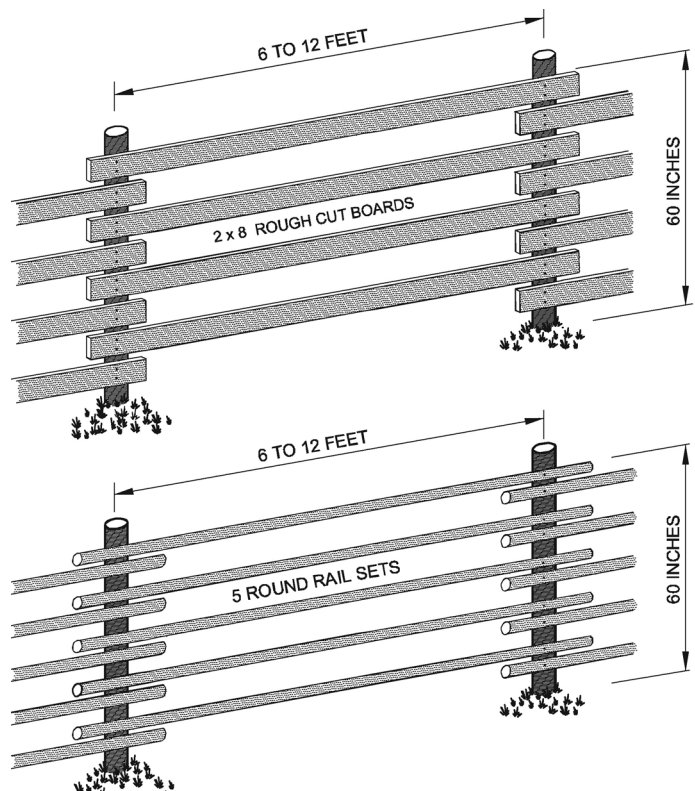


Figure 1 Post and Rail Fence for Cattle or Horses

Materials Required per Panel*		Description
Rails	4 boards or 5 rails	- 2 inch x 8 inch rough boards, or - 3 inch diameter round rails, peeled - use 4 boards or 5 round rails for corral or feedlot - less for pasture
Posts		- 4 to 5 inch diameter x 8 feet long; pasture - 5 to 6 inch diameter x 8 feet long; corral, feedlot - pressure-treated, pointed, domed - driven 2½ feet (min)
Nails	boards - 16 nails rails - 10 nails	- 5 inch ardox (spiral shank) - use 4 per board or 2 per rail

- Notes
1. Boards may be butt joined if they are twice the length of post spacing and the ground is level.
 2. Joints are alternated on posts.
 3. Place boards or rails on pressure (animal) side of posts.
If this is not possible, wire tie and/or nail an upright board over the joints.
 4. Bolts can be used in place of nails in high pressure situations such as feedlots.
 5. Flat steel washers (galvanized) may be used on nail heads for a larger surface contact area.

* A panel coverage of the right-of-way depends on post spacing - from 6 to 12 feet

USE:	cattle, horse; rangeland, pasture
RAILS:	3 or 4 logs
PANEL LENGTH:	12 to 14 feet
HEIGHT:	42 to 50 inches
*WIDTH:	6 to 7 feet
NOTES:	This is the basic log Fence design. It requires a wide right-of-way. See Factsheet 307.600-2 <i>Wood Fence Construction</i>

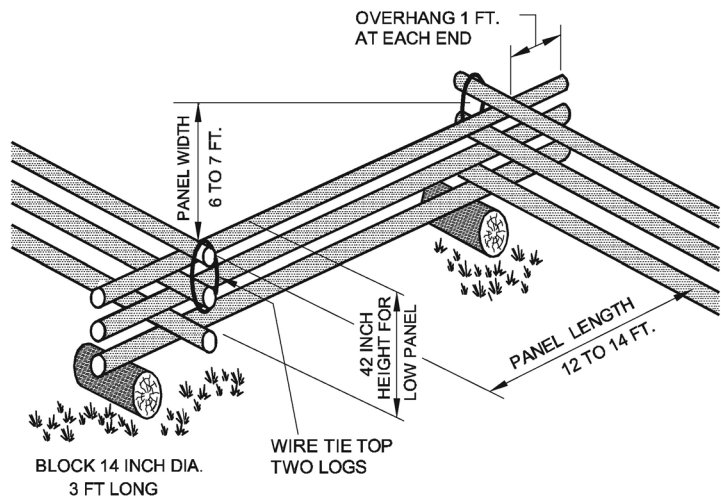


Figure 2 Snake Rail Fence

Materials Required per Panel* Description

Rails	3 or 4	- 6-inch diameter/4-log fence; 7-inch diameter/3-log fence x 14–16 feet long (lodgepole pine preferred) - three sides scored (min) or peeled - 1-foot overhang each end - notched on underside to fit rail or block below
Block	1	- 10-inch diameter/4-log fence; 14-inch diameter/3-log fence x 3 feet - peeled (pressure-treated preferred) - use flat rocks instead of wooden blocks where available
Tie Wire	5 feet	- #10 black wire

Crown range fences note: maximum height of 54 inches at the time of construction; create a fawn pass every 1,600 feet (use 15 inch blocks); create a wildlife jump every 1,600 feet (leave one end of the top log on the ground).

* Panel coverage: - a 12 ft panel (14 ft rails) will cover 9 ft along the right-of-way; a 14 ft panel (16 ft rails) covers 12 ft

* Panel width = panel length ÷ 2 (i.e., 12 ft panel length: $12 \div 2 = 6$ ft panel width). Or refer to Figure 3, below.

Design Options: To reduce the panel width, and increase the coverage, use either of the following modifications:

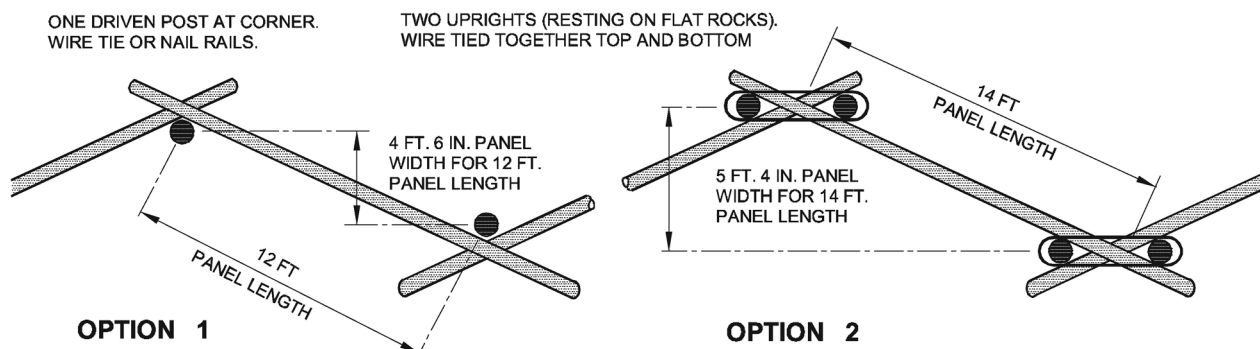


Figure 3 Reduced Panel Width Snake Rail Fences

USE: cattle, horse;
rangeland, pasture

RAILS: 3 or 4 logs

**PANEL
LENGTH:** 12 to 14 feet

HEIGHT: 42 to 50 inches

WIDTH: 3 or 4 foot block length

NOTES: This log fence design
has a narrow width
compared to the
snake rail fence. See
Factsheet 307.600-2
Wood Fence Construction

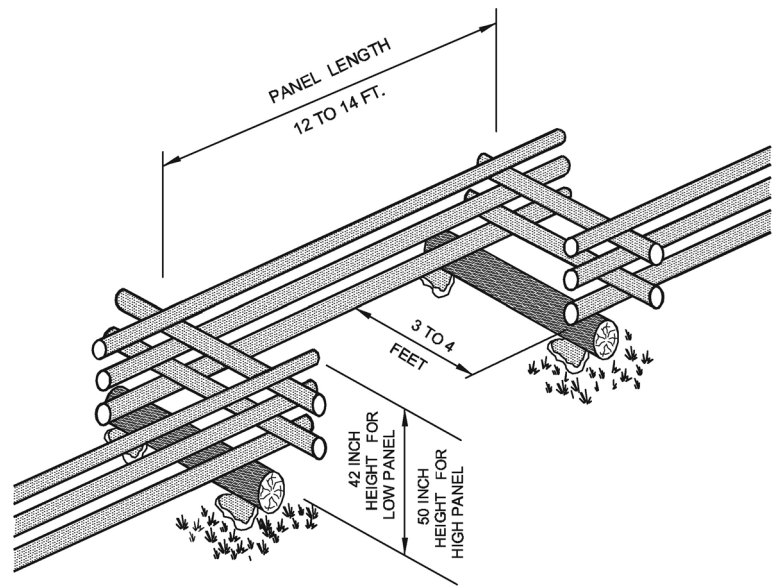


Figure 4 Log and Block Fence



Materials Required per Panel Description

Rails 3 or 4

- 6 to 7 inch diameter x 14 to 16 feet long
- three sides scored (min) or peeled
- 1 foot overhang each end.
- notch on underside to fit block

Blocks 3 or 4

- 10-inch diameter/4-log fence; 14-inch diameter/3-log fence x 4 feet
- other blocks 6–7 inch diameter x 3–4 feet long
- three sides scored (min) or peeled
- set bottom block on flat rocks, or treat the ground contact area (pressure-treated block preferred)

Crown range fences note: maximum height of 54 inches at the time of construction; create a fawn pass every 1,600 feet (use 15 inch blocks); create a wildlife jump every 1,600 feet (leave one end of the top log on the ground).

USE: cattle, horses;
rangeland, pasture

RAILS: 4 or 5 rails

**PANEL
LENGTH:** 12 feet

HEIGHT: 42 to 54 inches

WIDTH: 4 or 5 feet at supports

NOTES: A less used design that is labour intensive. Small diameter rails are used instead of logs. Untreated stake and tie poles will rot at ground contact points. Construction method requires practice. See Factsheet 307.600-2
Wood Fence Construction

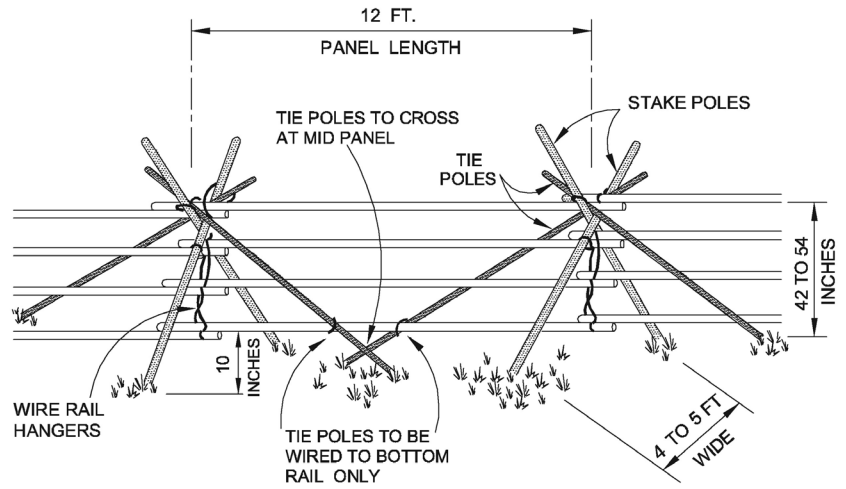


Figure 5 Russell Fence



Materials Required per Panel Description

Stake poles	2	- 2 @ 4 inch diameter x 6 ft long - 4 to 5 feet spread (to act as legs) - peeled, lodge pole pine preferred
Tie poles	2	- 2 @ 2 inch diameter x 10 feet long - to meet each other at mid panel - wired to bottom rail only - peeled, lodge pole pine preferred
Rails	4	- 4 @ 4 inch diameter x 14 feet long - may use 5 smaller diameter rails - may use split rails - peeled, lodge pole pine preferred
Tie Wire	approx. 20 feet	- #10 black wire to wire rail hangers, support and tie pole ties

Crown range fences note: maximum height of 54 inches and the bottom rail at least 18 inches from the ground, measured at the centre of the panel at the time of construction; create a wildlife jump every 1,600 feet (leave one end of the top rail on the ground).

NON-ELECTRIC WIRE FENCE DESIGNS FOR CATTLE

- USE:** cattle, rangeland;
low pressure
- WIRE:** 4 strands, barbed
- *POSTS:** spaced 15 feet
- HEIGHT:** 42 inches
- DROPPERS:** none
- *BRACES** spaced up to 660 feet
(8 per mile)
- NOTES:** This is the basic barbed
wire cattle design.

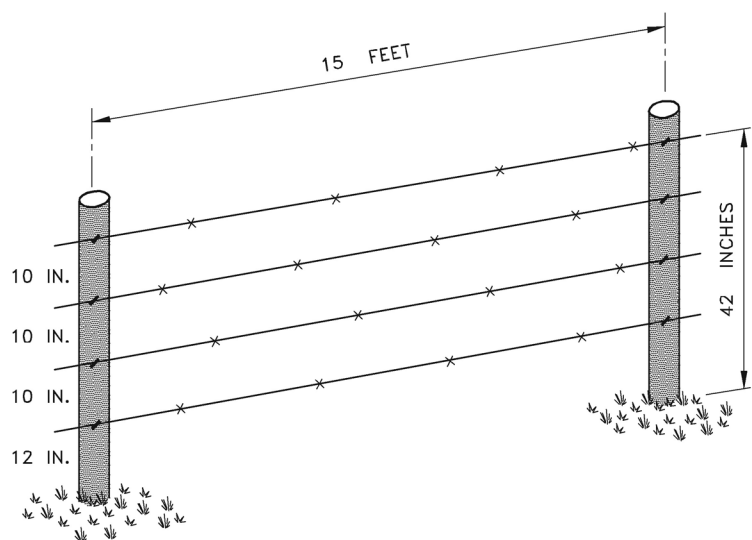


Figure 6 Four-Strand Barbed Wire Cattle Fence



Materials Required per Mile*		Description
Wire	16 rolls	- double strand barbed wire, 1,320 feet per roll - 12½ ga, 4-point barbs - Class 1 galvanizing (min.) - 950-lb breaking strength (min) - prestretch to 600 lb then relax to 250-lb tension when installing
Line Posts	*352	- 3 to 4 inch diameter x 7 feet long - pressure treated, pointed, domed - driven 2½ feet (min)
Brace Posts	*16	- 4 to 5 inch diameter x 8 feet long (2 per brace) - pressure treated, pointed, domed - driven 3½ feet (min)
Brace Rails	*8	- 4 to 5 inch diameter x 10 ft long (1 per brace) - optional 8 feet long set at ¾ of brace height (Factsheet 307.220-1 <i>Brace Assemblies for Wire Fences-What they Are, How They Work</i>)
Staples	½ box	- 1¾ inch, slash point, hot dip galvanized (2 in preferred) - angled across post grain by rotating away from the slash point - not driven home on line posts

* per mile of level terrain—rough terrain may require more posts and braces

USE: cattle;
medium pressure

WIRE: 5 strands, barbed

***POSTS:** spaced 20 feet

HEIGHT: 44 inches

DROPPERS: 1 spaced 10 feet
between posts

***BRACES:** spaced up to 660 feet
(8 per mile)

NOTES: Similar to Cattle 4-Strand
Barbed but with 25% fewer
posts, 25% more wire, and
droppers. The Cattle 4- and 5-Strand
Barbed designs have the same material costs.

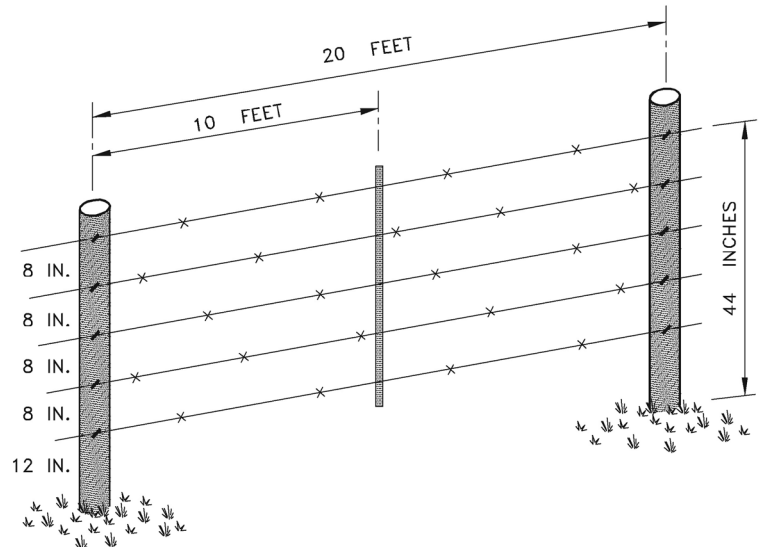


Figure 7 Five-Strand Barbed Wire Cattle Fence



Materials Required per Mile*

Wire 20 rolls

Description

- double strand barbed wire, 1,320 feet per roll
- 12½ ga, 4-point barbs
- Class 1 galvanizing (min)
- 950-lb breaking strength (min)
- prestretch to 600 lb then relax to 250-lb tension when installing

Line Posts *264

- 3 to 4 inch diameter x 7 feet long
- pressure treated, pointed, domed
- driven 2½ feet (min)

Brace Posts *16

- 4 to 5 inch diameter x 8 feet long (2 per brace)
- pressure treated, pointed, domed
- driven 3½ feet (min)

Brace Rails *8

- 4 to 5 inch diameter x 10 feet long (1 per brace)
- optional 8 feet long set at ¾ of brace height (Factsheet 307.220-1
Brace Assemblies for Wire Fences-What they Are, How They Work)

Droppers 264

- 1½-inch diameter wood or equivalent
- wire tied to fence wires with low tensile steel wire

Staples ½ box

- 1¾-inch, slash point, hot dip galvanized (2 inch preferred)
- angled across post grain by rotating away from the slash point
- not driven home on line posts

* per mile of level terrain—rough terrain may require more posts and braces

USE:	cattle, rangeland; low pressure
WIRE:	4 strand, htsw
*POSTS:	spaced 20 feet
HEIGHT:	42 inches
DROPPERS:	1 spaced 10 feet between posts
*BRACES:	spaced up to 1320 feet (4 per mile)
NOTES:	This is the basic htsw cattle design. A 24% savings in material costs over the Cattle 4- and 5-Strand Barbed designs.

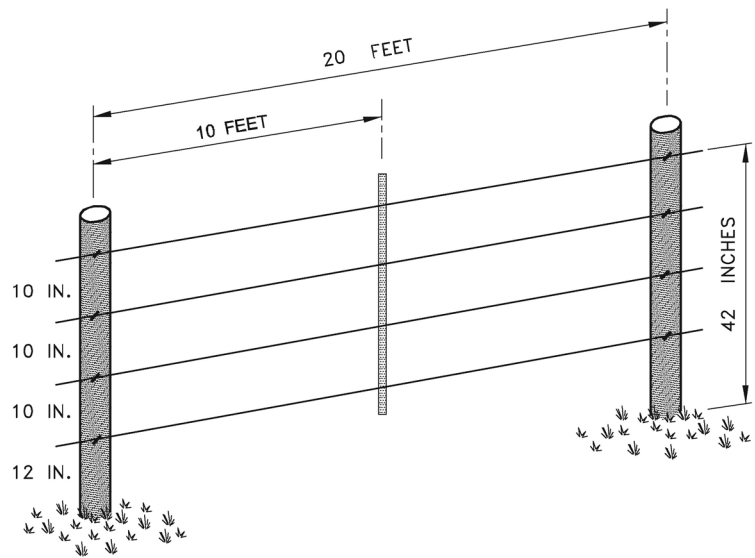


Figure 8 Four-Strand High Tensile Smooth Wire Cattle Fence

Materials Required per Mile*		Description
Wire	5.7 rolls	- single-strand htsw, 3,750 feet per 100 lb roll - 12½ ga, Class 3 galvanizing (standard) - 1350 lb breaking strength (min) - tensioned to 250 lb
Line Posts	*264	- 3 to 4 inch diameter x 7 feet long - pressure treated, pointed, domed - driven 2½ feet (min)
Brace Posts	*8	- 4 to 5 inch diameter x 8 feet long (2 per brace) - pressure treated, pointed, domed - driven 3½ feet (min)
Brace Rails	*4	- 4 to 5 inch diameter x 10 feet long (1 per brace) - optional 8 feet long set at ¾ of brace height (Factsheet 307.220-1 <i>Brace Assemblies for Wire Fences-What they Are, How They Work</i>)
Droppers	264	- suitable for htsw (Factsheet 307.100-3 <i>Droppers for Wire Fences</i>)
Staples	½ box	- 2-inch, slash point, hot dip galvanized - angled across post grain by rotating away from the slash point - not driven home on line posts
Tensioners	16	- 1 per strand per brace section - suitable for htsw

* per mile of level terrain—rough terrain may require more posts and braces

USE:	cattle, rangeland, pasture medium pressure
WIRE:	5 strands, htsw
*POSTS	spaced 30 feet
HEIGHT:	44 inches
DROPPERS:	2 spaced 10 feet between posts
*BRACES	spaced up to 1320 feet (4 per mile)
NOTES:	Most popular htsw design. Similar to Cattle 4-Strand Smooth design but with 33% fewer posts, 25% more wire, and 33% more droppers. Same material cost as Cattle 4- and 6-Strand Smooth designs.

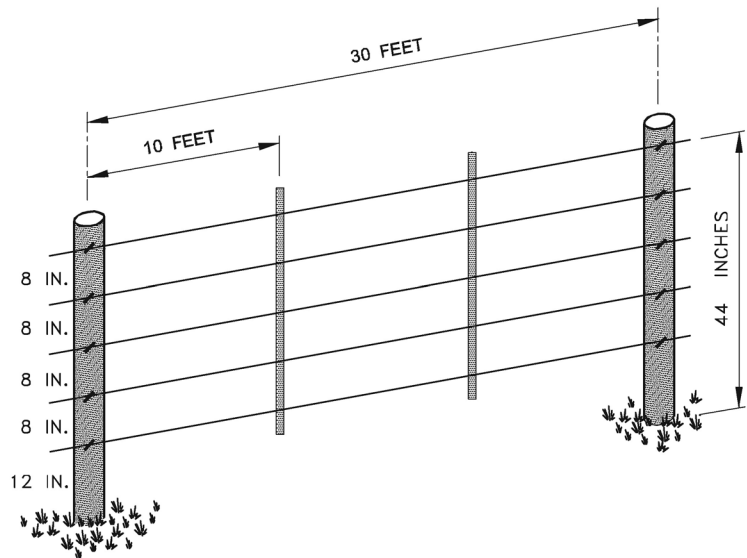


Figure 9 Five-Strand High Tensile Smooth Wire Cattle Fence

Materials Required per Mile*		Description
Wire	7.1 rolls	- single strand htsw, 3,750 feet per 100 lb roll - 12½ ga, Class 3 galvanized (standard) - 1350 lb breaking strength (min) - tensioned to 250 lb
Line Posts	*176	- 3 to 4 inch diameter x 7 feet long - pressure treated, pointed, domed - driven 2½ feet (min)
Brace Posts	*8	- 4 to 5 inch diameter x 8 feet long (2 per brace) - pressure treated, pointed, domed - driven 3½ feet (min)
Brace Rails	*4	- 4 to 5 inch diameter x 10 feet long (1 per brace) - optional 8 feet long set at ¾ of brace height (Factsheet 307.220-1 <i>Brace Assemblies for Wire Fences-What they Are, How They Work</i>)
Droppers	352	- suitable for htsw (Factsheet 307.100-3 <i>Droppers for Wire Fences</i>)
Staples	1/3 box	- 2 inch, slash point, hot dip galvanized - angled across post grain by rotating away from the slash point - not driven home on line posts
Tensioners	20	- 1 per strand per brace section - suitable for htsw

* per mile of level terrain—rough terrain may require more posts and braces

USE: cattle; medium pressure

WIRE: 6 strands, htsw

***POSTS:** spaced 40 feet

HEIGHT: 44 inches

DROPPERS: 3 spaced 10 feet
between posts

***BRACES** spaced up to 1320 feet
(4 per mile)

NOTES: Suitable for level terrain.
Similar to Cattle 5-Strand Smooth
design but with 25% fewer posts,
20% more wire, 13% more droppers.
Same material cost as Cattle 4- and
5-Strand Smooth designs.

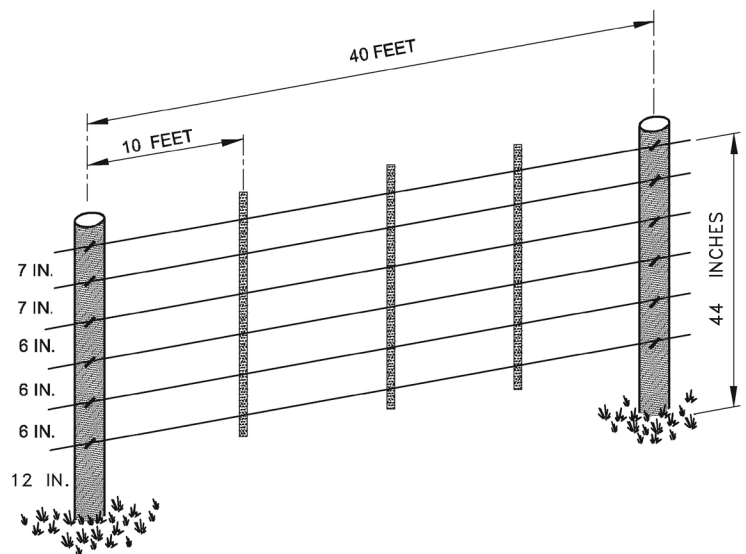


Figure 10 Six-Strand High Tensile Smooth Wire Cattle Fence

Materials Required per Mile*		Description
Wire	8.5 rolls	- single strand htsw, 3,750 feet per 100 lb roll - 12½ ga, Class 3 galvanized (standard) - 1350 lb breaking strength (min) - tensioned to 250 lb
Line Posts	*132	- 3 to 4 inch diameter x 7 feet long - pressure treated, pointed, domed - driven 2½ feet (min)
Brace Posts	*8	- 4 to 5 inch diameter x 8 feet long (2 per brace) - pressure treated, pointed, domed - driven 3½ feet (min)
Brace Rails	*4	- 4 to 5 inch diameter x 10 feet long (1 per brace) - optional 8 feet long set at ¾ of brace height (Factsheet 307.220-1 <i>Brace Assemblies for Wire Fences-What they Are, How They Work</i>)
Droppers	396	- suitable for htsw (Factsheet 307.100-3 <i>Droppers for Wire Fences</i>)
Staples	1/3 box	- 2 inch, slash point , hot dip galvanized - angled across post grain by rotating away from the slash point - not driven home on line posts
Tensioners	24	- 1 per strand per brace section - suitable for htsw

* per mile of level terrain—rough terrain may require more posts and braces

USE: cattle; high pressure

WIRE: 6 or 8 strands, htsw

***POSTS** spaced 20 or 30 feet

HEIGHT: 44 or 45 inches

DROPPERS: 3 spaced 5 or 7 ½ feet between posts

***BRACES** spaced up to 1320 feet (4 per mile)

NOTES: Suitable for intensive feeding cows or calves. No wind protection as with wood board fencing but lower cost.

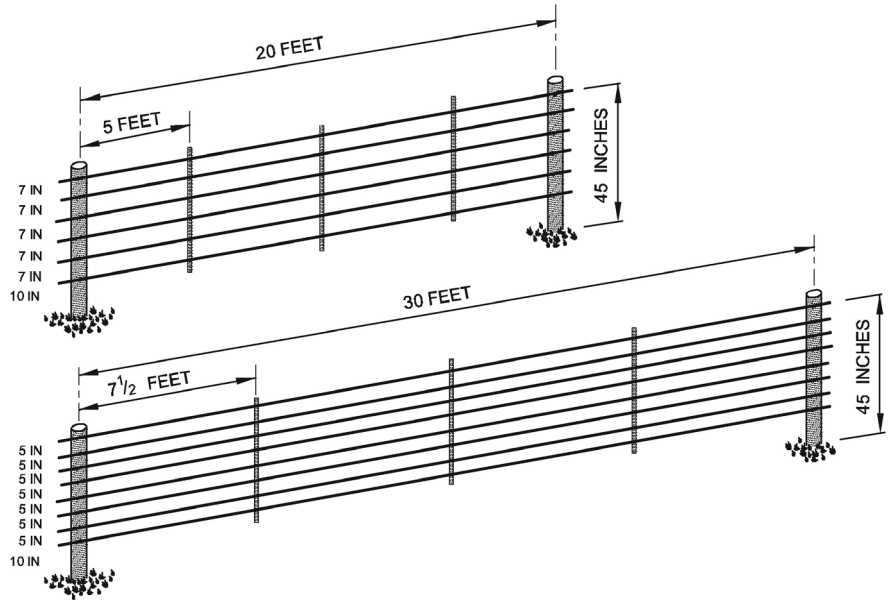


Figure 11 Six-and Eight-Strand High Tensile Smooth Wire Cattle Fences

Materials Required per Mile*		Description
Wire	6 strand - 8.5 rolls 8 strand - 11.3 rolls	- single strand htsw, 3,750 feet per 100 lb roll - 12½ ga, Class 3 galvanized (standard) - 1350 lb breaking strength (min) - tensioned to 250 lb
Line Posts	6 strand -*264 8 strand -*176	- 3 to 4 inch diameter x 7 feet long - pressure treated, pointed, domed - driven 2½ feet (min)
Brace Posts	*8	- 5 to 6 inch diameter x 8 feet long (2 per brace) - pressure treated, pointed, domed - driven 4 feet (min)
Brace Rails	*4	- 4 to 5 inch diameter x 10 feet long (1 per brace) - optional 8 feet long set at ¾ of brace height (Factsheet 307.220-1 <i>Brace Assemblies for Wire Fences-What they Are, How They Work</i>)
Droppers	6 strand – 792 8 strand - 528	- suitable for htsw (Factsheet 307.100-3 <i>Droppers for Wire Fences</i>)
Staples	6 strand -½ box 8 strand - ¾ box	- 2 inch, slash point , hot dip galvanized - angled across post grain by rotating away from the slash point - not driven home on line posts
Tensioners	6 strand –24 8 strand –32	- 1 per strand per brace section - suitable for htsw

Notes

1. For very high pressure situations (such as feedlot) use 8 strands with posts at 20 feet.
2. For high pressure on both sides of a fence, posts can be drilled and the wire threaded through the post rather than stapled on one side. Or alternate the wires from side-to-side of posts.
3. Double span braces may be required.

* per mile of level terrain—rough terrain may require more posts and braces

USE:	cattle; medium to high pressure
WIRE:	woven 9 or 10 horizontals 6 or 12 inch spaced verticals
*POSTS	spaced 20 feet
HEIGHT:	42 to 53 inches
DROPPERS:	none
*BRACES:	spaced up to 660 feet (8 per mile)
NOTES:	Higher security but more material costs than either barbed or htsw.

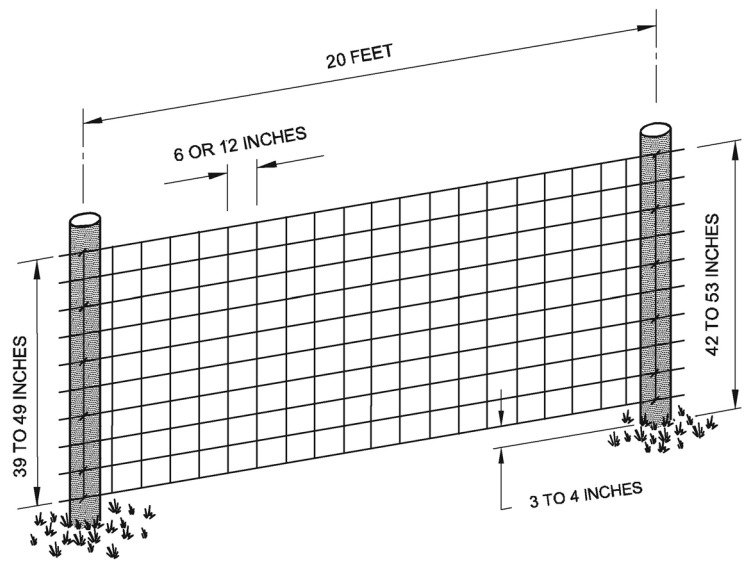


Figure 12 Woven Wire Cattle Fence

Materials Required per Mile*		Description
Wire	16 rolls	- woven; 9/49 knotted joint or 9/39, 10/47 hinged joint - 6 or 12 inch spacing on vertical wires - 12½ ga,(some have heavier top and bottom wire) - galvanized, 330 feet per roll, 115 to 183 lb
Line Posts	*264	- 3 to 4 inch diameter x 7 feet long - pressure treated, pointed, domed - driven 2½ feet (min)
Brace Posts	*16	- 4 to 5 inch diameter x 8 feet long (2 per brace) - pressure treated, pointed, domed - driven 3½ feet (min)
Brace Rails	*8	- 4 to 5 inch diameter x 10 feet long (1 per brace) - optional 8 feet long set at ¾ of brace height (Factsheet 307.220-1 <i>Brace Assemblies for Wire Fences-What they Are, How They Work</i>)
Staples	½ box	- 1¾ inch, slash point , hot dip galvanized - angled across post grain by rotating away from the slash point - not driven home on line posts

* per mile of level terrain—rough terrain may require more posts and braces

NON-ELECTRIC WIRE FENCE DESIGNS FOR HORSES

- USE:** horses; low to medium pressure
- WIRE:** 6 strands, htsw
- *POSTS** spaced 20 feet
- HEIGHT:** 52 inches
- DROPPERS:** 1 spaced 10 feet between posts
- *BRACES:** spaced up to 1320 feet (4 per mile)
- NOTES:** Some concern about horses catching hooves in individual strand wire fences. See Factsheet 307.260-3 *Pasture Fencing for Horses*

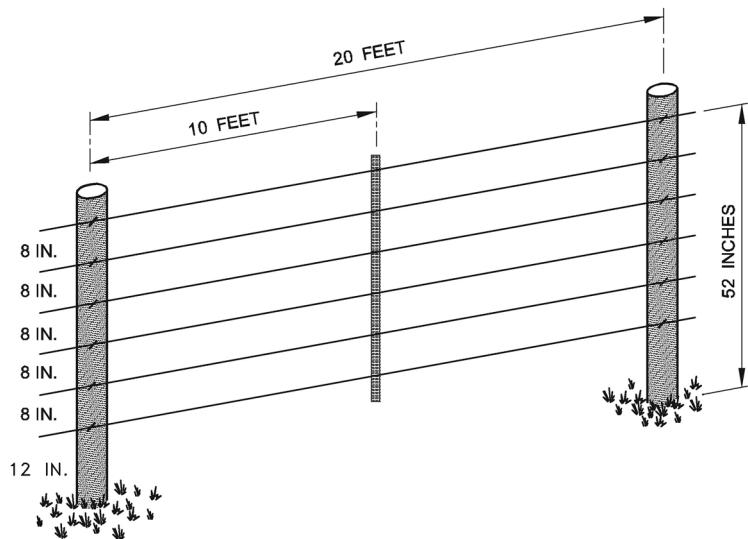


Figure 13 Six-Strand High Tensile Smooth Wire Horse Fence



Materials Required per Mile*		Description
Wire	8.5 rolls of htsw	- single strand htsw, 3,750 feet per 100 lb roll - 12½ ga, Class 3 galvanizing (standard) - 1350 lb breaking strength (min) - tensioned to 250 lb
Line Posts	*264	- 3 to 4 inch diameter x 7 feet long - pressure treated, pointed, domed - driven 2½ feet (min)
Brace Posts	*8	- 4 to 5 inch diameter x 8 feet long (2 per brace) - pressure treated, pointed, domed - driven 3½ feet (min)
Brace Rails	*4	- 4 to 5 inch diameter x 10 feet long (1 per brace) - optional 8 feet long set at ¾ of brace height (Factsheet 307.220-1 <i>Brace Assemblies for Wire Fences-What they Are, How They Work</i>)
Droppers	264	- suitable for htsw (Factsheet 307.100-3 <i>Droppers for Wire Fences</i>)
Staples	½ box	- 2 inch, slash point , hot dip galvanized - angled across post grain by rotating away from the slash point - not driven home on line posts
Tensioners	24	- 1 per strand per brace section - suitable for htsw

* per mile of level terrain—rough terrain may require more posts and braces

USE: horses; high pasture

WIRE: woven
9 or 10 horizontals
6 or 12 inch spaced
verticals

***POSTS** spaced 20 feet

HEIGHT: 52 to 59 inches

DROPPERS: none

***BRACES** spaced up to 660 feet
(8 per mile)

NOTES: For horse fencing
materials information,
see Factsheet 307.260-3
Pasture Fencing for Horses.

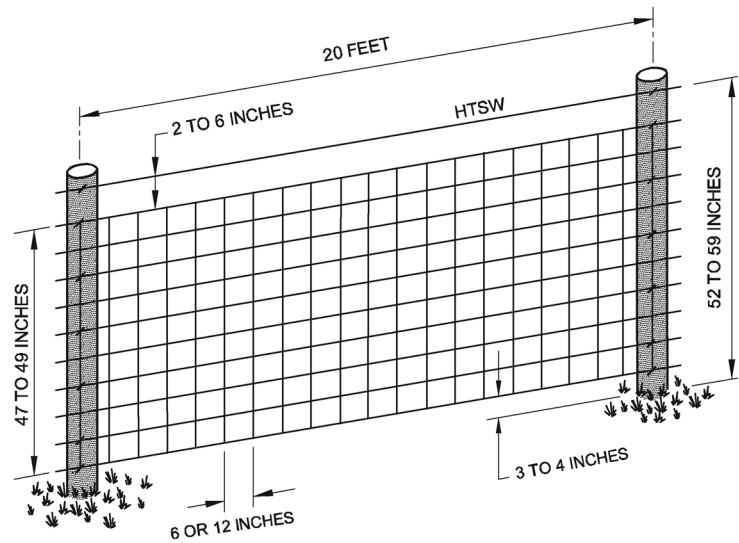


Figure 14 Woven Wire Horse Fence

Note, that this fence design materials description and required amounts are the same as for the *Woven Wire Cattle Fence* design, page 15, except for the following:

- woven wire choices are 9/49 or 12/48 knotted joint, or 10/47 hinged joint, at either 6 or 12 inch spaced vertical wires.
- choose knotted joint wire in high pressure applications.
- some horses may catch hooves in the 12 inch spaced vertical woven wire; choose either the 6 inch spacing or special “diamond” weave wire.
- use one or more top strands of htsw (possibly electrified) for added height (requires 1.4 rolls htsw per mile for each extra top wire).
- refer to Factsheet 307.260-3 *Pasture Fencing for Horses*, for horse fence materials information.

NON-ELECTRIC WIRE FENCE DESIGNS FOR SHEEP

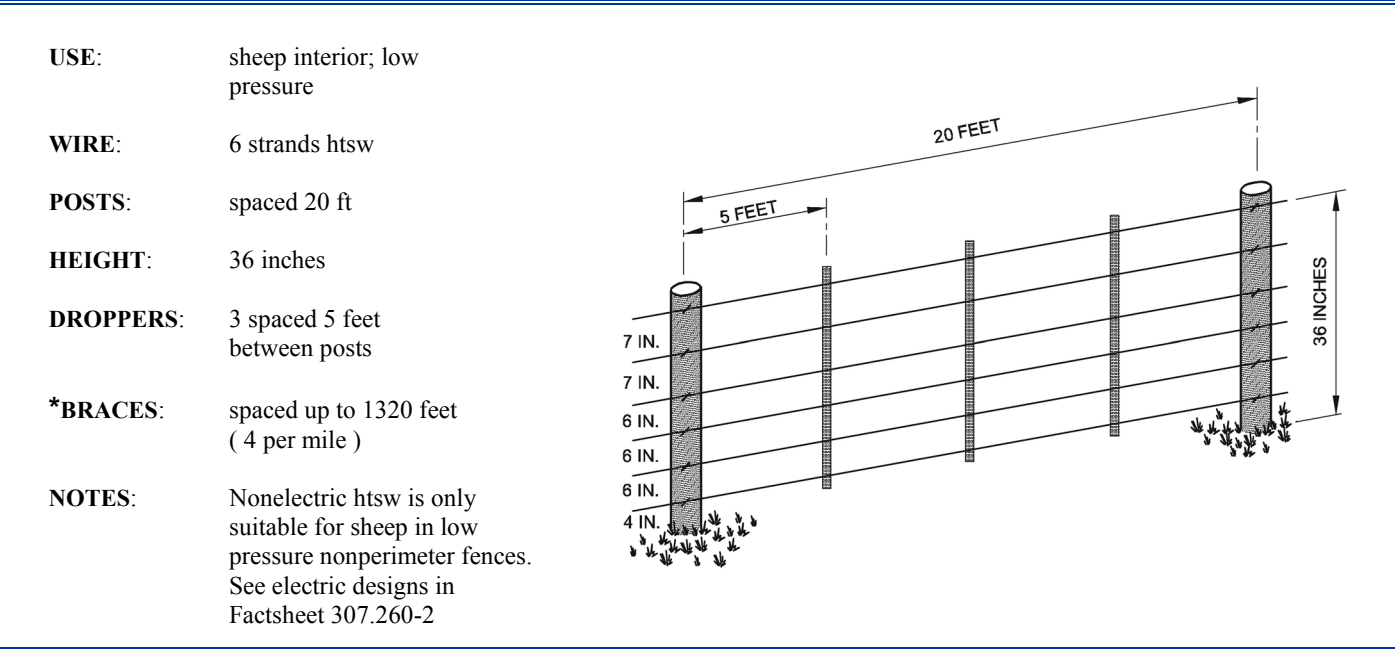


Figure 15 **Six-Strand High Tensile Smooth Wire Sheep Fence**

Materials Required per Mile* Description

Wire	8.5 rolls	- single strand htsw, 3,750 feet per 100 lb roll - 12½ ga, Class 3 galvanized (standard) - 1350 lb breaking strength (min) - tensioned to 250 lb
Line Posts	*264	- 3 to 4 inch diameter x 7 feet long - pressure treated, pointed, domed - driven 2½ feet (min)
Brace Posts	*8	- 4 to 5 inch diameter x 8 feet long (2 per brace) - pressure treated, pointed, domed - driven 3½ feet (min)
Brace Rails	*4	- 4 to 5 inch diameter x 10 feet long (1 per brace) - optional 8 feet long set at ¾ of brace height (Factsheet 307.220-1 <i>Brace Assemblies for Wire Fences-What they Are, How They Work</i>)
Droppers	792	- suitable for htsw (Factsheet 307.100-3 <i>Droppers for Wire Fences</i>)
Staples:	½ box	- 2 inch, slash point, hot dip galvanized - angled across post grain by rotating away from the slash point - not driven home on line posts
Tensioners	24	- 1 per strand per brace section - suitable for htsw

* per mile of level terrain—rough terrain may require more posts and braces



USE: sheep perimeter;
medium to high pressure

WIRE: woven
7 to 10 horizontals
6 inch spaced verticals

***POSTS:** spaced 15 feet

HEIGHT: 34 to 41 inches

DROPPERS: none

***BRACES** spaced 660 feet
(8 per miles)

NOTES: This is the standard
perimeter fence for sheep

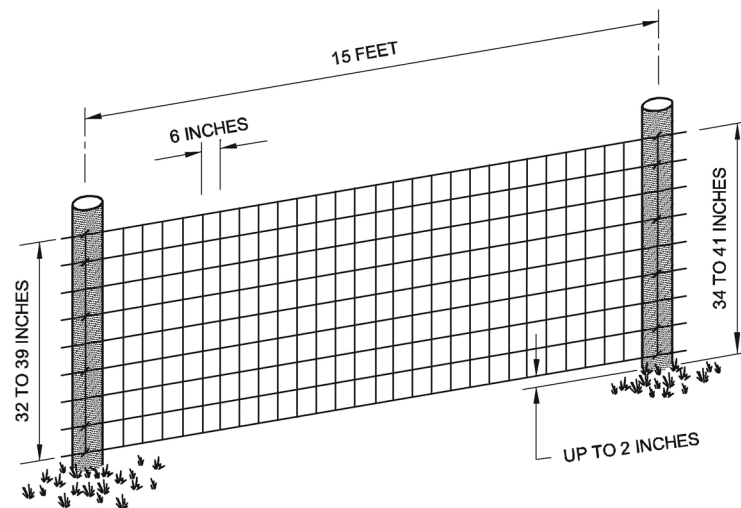


Figure 16 Woven Wire Sheep Fence

Materials Required per Mile*		Description
Wire	16 rolls	- woven; 8/32 or 9/39 hinged joint (9/49 knotted joint available) - 6 in spacing on vertical wires - 12½ ga, (some have heavier top & bottom wires) - galvanized, 330 feet per roll, 132–153 lb
Line Posts	*352	- 3 to 4 inch diameter x 7 feet long - pressure treated, pointed, domed - driven 2½ feet (min)
Brace Posts	*16	- 4 to 5 inch diameter x 8 feet long (2 per brace) - pressure treated, pointed, domed - driven 3½ feet (min)
Brace Rails	*8 brace rails	- 4 to 5 inch diameter x 10 feet long (1 per brace) - optional 8 feet long set at ¾ of brace height (Factsheet 307.220-1 <i>Brace Assemblies for Wire Fences-What they Are, How They Work</i>)
Staples	½ box	- 1¾ inch, slash point , hot dip galvanized - angled across post grain by rotating away from the slash point - not driven home on line posts

Note - Woven wire suitable for sheep is available in heights from 26 to 39 inch. To obtain the required total height use one or more strands of barbed or htsw above the woven wire and/or set the bottom of the wire 2 inch. about the ground.

* per mile of level terrain—rough terrain may require more posts and braces

NON-ELECTRIC WIRE FENCE DESIGNS FOR BISON

- USE:

farmed bison; perimete
- WIRE:

5 strands barbed
6 strands optional¹
- *POSTS:

spaced 18 feet
- HEIGHT:

54 inches
66 inches optional
- DROPPERS:

2 spaced 6 feet
between posts
- *BRACES

spaced up to 660 feet
(8 per miles)
- NOTES:

May be extended to
66 inches high with one
extra strand¹ at 12 inches
and longer posts² or po:
extensions. See also hts
and woven wire design.

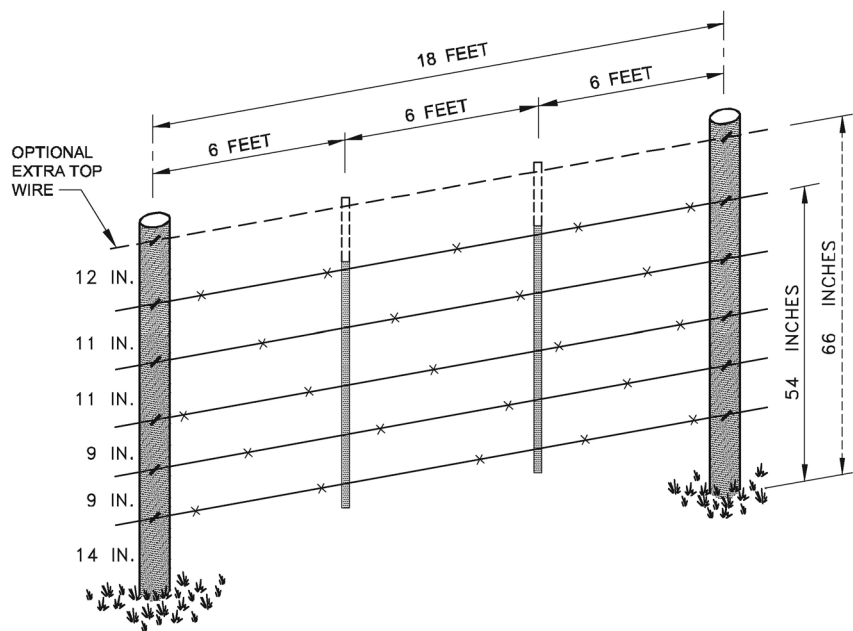


Figure 17 Five-Strand Barbed Wire Bison Perimeter Fence

Materials Required per Mile*		Description
Wire	20 rolls ¹	- double strand barbed wire, 1,320 feet per roll - 12½ ga, 4 point barbs - Class 1 galvanizing, 950 lb breaking strength (min) - prestretch to 600 lb then relax to 250 lb when installing
Line Posts	*294	- 3 to 4 inch diameter x 7 feet long ² - pressure treated, pointed, domed - driven 2½ feet (min)
Brace Posts	16	- 5 to 6 inch diameter x 8 feet long (2 per brace) ³ - pressure treated, pointed, domed - driven 3½ feet (min)
Brace Rails	8	- 4 to 5 inch diameter x 10 feet long (1 per brace) - optional 8 feet long set at ¾ of brace height (Factsheet 307.220-1 <i>Brace Assemblies for Wire Fences-What they Are, How They Work</i>)
Droppers	588	- 1½ inch dia wood or equivalent
Staples	½ box	- 2 inch, slash point, hot dip galvanized (barbed staples optional) - angled across post grain by rotating away from slash point - not driven home on line posts

- Notes
1. If extra top wire is used (for 6 strands total) require 24 rolls barbed wire total per mile.

2. 8 ft line posts required if extra top wire used

3. 9 ft brace posts required if extra top wire used

* per mile of level terrain—rough terrain may require more posts and braces

USE:	farmed bison; perimeter
WIRE:	7 strands htsw 8 strands optional ¹
*POSTS	spaced 18 feet
HEIGHT:	54 inches 66 inches optional
DROPPERS:	2 spaced 6 feet between posts
*BRACES:	spaced up to 1320 feet (4 per mile)
NOTES:	May be extended to 66 inches high with one extra strand ¹ at 12 inches and longer posts ² or post extensions. See also barbed and woven wire designs.

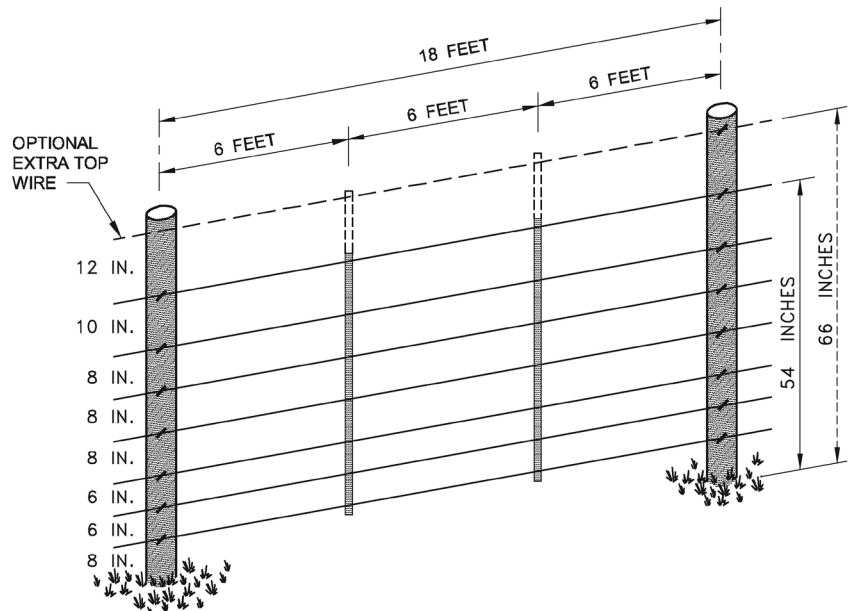


Figure 18 Seven-Strand High Tensile Smooth Wire Bison Perimeter Fence

Materials Required per Mile*		Description
Wire	9.9 rolls ¹	- single strand htsw, 3,750 feet per roll - 12½ ga, Class 3 galvanized (standard) - 1350 lb breaking strength (min) - tensioned to 250 lb
Line Posts	294	- 3 to 4 inch diameter x 7 fet long² - pressure treated, pointed, domed - driven 2½ feet (min)
Brace Posts	8	- 5 to 6 inch diameter x 8 feet long (2 per brace)³ - pressure treated, pointed, domed - driven 3½ feet (min)
Brace Rails	4	- 4 to 5 inch diameter x 10 feet long (1 per brace) - optional 8 feet long set at ¾ of brace height (Factsheet 307.220-1 <i>Brace Assemblies for Wire Fences-What they Are, How They Work</i>)
Droppers	588	- suitable for htsw (Factsheet 307.100-3 <i>Droppers for Wire Fences</i>)
Staples	½ box	- 2 inch, slash point, hot dip galvanized (barbed staples optional) - angled across post grain by rotating away from the slash point - not driven home on line posts
Tensioners	28	- 1 per strand per brace section - suitable for htsw

Notes

1. If extra top wire is used (8 strands total) require 11.3 rolls of htsw
2. 8 ft line posts required if extra top wire use
3. 9 ft brace posts required if extra top wire used

* per mile of level terrain—rough terrain may require more posts and braces

USE: farmed bison perimeter;
high pressure

WIRE: woven
10 horizontals
12 inch spaced verticals

***POSTS:** spaced 15 feet

HEIGHT: up to 64 inches

DROPPERS: none

***BRACES:** spaced up to 660 feet
(8 per mile)

NOTES: A high grade perimeter
bison fence. Choose for
high pressure areas, along
public roads, etc. See also
barbed and htsw designs.

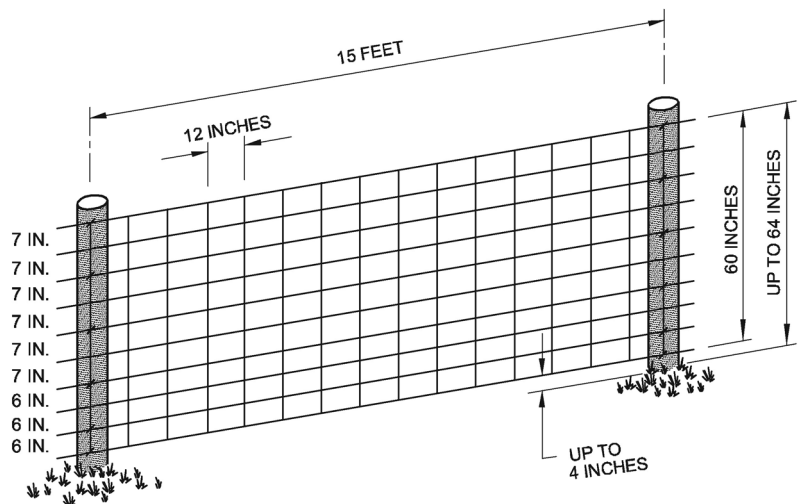


Figure 19 Woven Wire Bison Perimeter Fence



Materials Required per Mile*

Wire 8 rolls

Line Posts *352

Brace Posts *16

Brace Rails 8

Staples 5/8 box

Description

- 10/60/12, knotted joint
- 10 horizontals, 60 in high,
- 12 in spacing on verticals
- 12½ ga high tensile horizontals
- medium tensile verticals
- galvanized, 660 feet per roll, 290 lb

- 3 to 4 inch diameter x 8 feet long
- pressure treated, pointed, domed
- driven 2½ feet (min)

- 5 to 6 inch diameter x 9 feet long (2 per brace)
- pressured treated, pointed, domed
- driven 3½ feet (min)

- 4 to 5 inch diameter x 10 feet long (1 per brace)
- optional 8 feet long set at ¾ of brace height (Factsheet 307.220-1
Brace Assemblies for Wire Fences-What they Are, How They Work)

- 2 inch, slash point, hot dip galvanized
- angled across post grain by rotating away from the slash point
- not driven home on line posts

* per mile of level terrain—rough terrain may require more posts and braces

NON-ELECTRIC WIRE FENCE DESIGNS FOR GAME FARM DEER

USE: reindeer, cross fence;
low pressure, pasture division fence

Wire: 5 strands, htsw

***POSTS:** spaced 15 feet

HEIGHT: 48 inches

DROPPERS: 2 spaced 5 feet
between posts

***BRACES:** spaced up to 1320 feet
(4 per mile)

NOTES: Also for bison. May be used for
fallow deer. NOT FOR FAWNS.
This can be electrified for greater stock
control. See electric designs in Factsheet 307.260-2

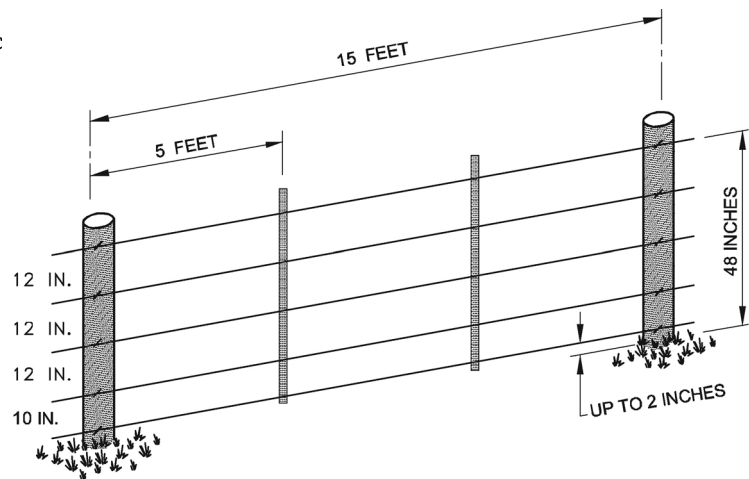


Figure 20 Five-Strand High Tensile Smooth Wire Game Farm Deer Interior Fence

Materials Required per Mile*		Description
Wire	8.5 rolls	- single strand htsw, 3,750 feet per 100 lb roll - 12½ ga Class 3 galvanized (standard) - 350 lb breaking strength (min) - tensioned to 250 lb
Line Posts	*352	- 3 to 4 inch diameter x 7 feet long - pressure treated, pointed domed - driven 2½ feet (min)
Brace Posts	*8	- 4 to 5 inch diameter x 8 feet long (2 per brace) - pressure treated, pointed, domed - driven 3½ feet (min)
Brace Rails	*4	- 4 to 5 inch diameter x 10 feet long (1 per brace) - optional 8 feet long set at ¾ of brace height (Factsheet 307.220-1 <i>Brace Assemblies for Wire Fences-What they Are, How They Work</i>)
Droppers	704	- suitable for htsw (Factsheet 307.100-3 <i>Droppers for Wire Fences</i>)
Staples	¾ box	- 2 inch, slash point, hot dip galvanized - angled across post grain by rotating away from the slash point - not driven home on line posts
Tensioners	20	- 1 per strand per brace section - suitable for htsw

* per mile of level terrain—rough terrain may require more posts and braces

USE:	farmed fallow deer, reindeer perimeter (permit standards)
WIRE:	woven; 17 or 18 horizontals 6 inch spaced verticals for fallow, or 12 inch spaced verticals for reindeer
*POSTS:	spaced 20 feet
HEIGHT:	84 inches minimum
DROPPERS:	none
*BRACES:	spaced up to 660 feet (8 per mile)
NOTES:	Perimeter fence for game farm licence. See Factsheet 307.271-1 <i>Deer Farm Perimeter Fencing</i>

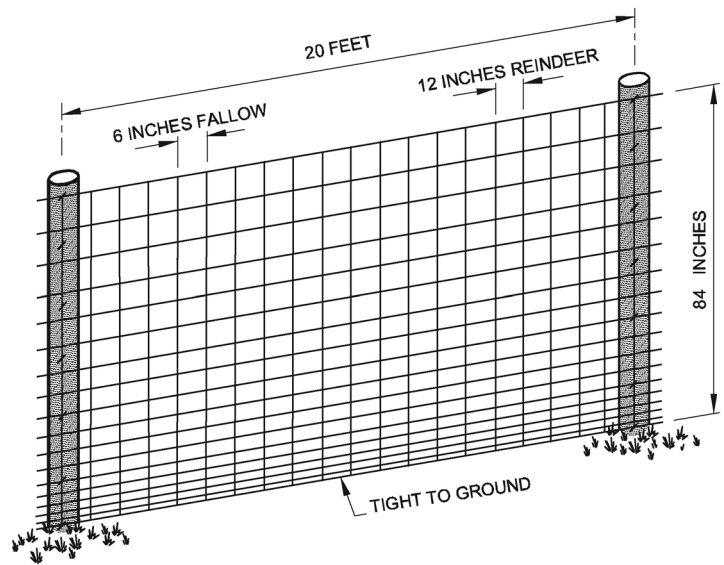


Figure 21 Woven Wire Game Deer Perimeter Fence

Materials Required per Mile* Description

Wire	16 rolls	- knotted joint required for perimeter fence permit - horizontal wire spacing is graduated - high tensile wire horizontals, medium tensile verticals - 18/86 for full height, all woven - 6 in spaced verticals (fallow deer) -12 in spaced verticals (reindeer) - galvanized, 330 feet per roll; 237 to 358 lb roll weight
Line Posts	*264	- 4 to 5 inch diameter x 10 feet long - pressure treated, pointed, domed - driven 3 feet.
Brace Posts	*16	- 5 to 6 inch diameter x 11 feet long (2 per brace) - pressure treated, pointed, domed - driven 4 feet
Brace Rails	*8	- 4 to 5 in. diameter x 10 feet long (1 per brace) set at $\frac{3}{4}$ brace height
Staples	$\frac{3}{4}$ box	- 2 inch slash point, hot dipped galvanized - angled across post grain by rotating away from the slash point - not driven home on line posts



Note - do not use any material that is “bolder” than wire (i.e., a wood plank) along the top of the fence as deer can jump 7 feet if they can clearly see the top of the fence.

* per mile of level terrain—rough terrain may require more posts and braces

USE: farmed fallow deer,
reindeer interior;
medium to high pressure

WIRE: woven
15 horizontals
6 or 12 inch spaced verticals

***POSTS:** spaced 20 feet

HEIGHT: 60 inches or greater

DROPPERS: none

***BRACES:** spaced up to 660 feet
(8 per mile)

NOTES: Pasture division fence.
The 6 inch vertical spaced
woven wire is fawn proof.

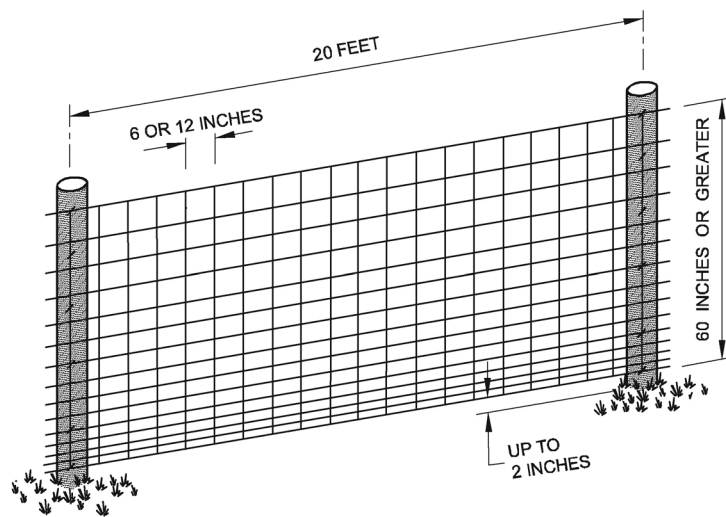


Figure 22 Woven Wire Game Deer Interior Fence



Materials Required per Mile*

Description

Wire	16 rolls	- horizontal wire spacing is graduated - high tensile wire horizontals, medium tensile verticals - 15/61 knotted joint preferred, or 11/62 hinged joint and 10/60 knotted joint available - 6 in or 12 in spaced verticals - galvanized, 330 feet per roll; 150 to 282 lb roll weight
Line Posts	*264	- 3 to 4 inch diameter x 8 feet long - pressure treated, pointed domed - driven 2½ feet
Brace Posts	*16	- 4 to 5 inch diameter x 9 feet long (2 per brace) - pressure treated, pointed, domed - driven 3½ feet minimum
Brace Rails	8	- 4 to 5 inch diameter by 10 ft long (1 per brace) - optional 8 feet long set at ¾ of brace height (Factsheet 307.220-1 <i>Brace Assemblies for Wire Fences - What They Are, How They Work</i>)
Staples	½ box	- 2 inch slash point, hot dip galvanized - angled across post grain by rotating from the slash point - not driven home on line posts

* per mile of level terrain—rough terrain may require more posts and braces

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LIVESTOCK CONTROL ELECTRIC FENCE DESIGNS

Introduction

A wire fence design refers to the physical description and spacings of the wire, line post and dropper components for a particular fence. The following specifications are typically required for an electric fence:

- description of wire
- number of wires
- wire spacings
- post spacing
- dropper spacing (if used)
- which wires are electrified
- and where applicable, which wires are grounded

These specifications must be chosen taking into account the various planning points; the three main ones being fence purpose, type of animal and site conditions. The other details of the fence such as post size, brace design, dropper type, insulator type, etc. are set by construction practice once the above specifications have been selected.

Six permanent designs and two temporary designs are outlined, each having their unique specifications.

ELECTRIC FENCE DESIGNS FOR LIVESTOCK CONTROL

Electric fencing has additional concerns over non electric in that an electric circuit is being constructed. Not only are braces built, posts driven and wires strung but an electric circuit free of shorts and points of high resistance must be assembled. The quality of line post insulators, tie off insulators, wire connections and the fence controller will all determine the effectiveness and long term maintenance of the fence designs.

One concern of electric fences bears repeating here:

“An electric fence may be inexpensive but it can’t be built cheap.”

Electric fence designs should **not** be chosen only to save money. The problems with electric fences are usually the result of an inadequate design, inferior materials and poor construction.

For safety reasons, the following designs use either smooth steel wire (htsw) or “poly” wire. **Barbed wire should not be electrified.**

Electric Fences for Cattle & Sheep

Controlling cattle and sheep with electric fences is mainly done for improved grazing. The majority of cattle and sheep fences may be non-electric but the cost saving advantages of electric fence designs are essential when considering intensified grazing systems. Both temporary and permanent designs are used on both the perimeter and cross fences

Electric Fences for Horse

Electric fencing for horses is usually an electrified wire or two in problem areas, such as to prevent chewing of wood boards or rails. However, to discourage horses from pushing under a bottom wire or leaning over a top wire, a non-electric smooth wire design can be modified by electrifying the top and/or bottom wire. Refer to Factsheet 307.260-3 *Pasture Fencing for Horses* regarding non-electric pasture fences for horses that could be modified.

Electric Fences for Game

Because Game Farm policy for perimeter fence design is for woven wire (non electric), only interior game fences will usually be totally electrified. Individual electric strands may be added to the perimeter fence for greater livestock or predator control. Locate these at a height for good animal contact.

Interior electric fences will be used mainly for grazing control or stock separation. At this time, experience with electric game fences is limited but they can be expected to react similar to other livestock. Woven wire game fences are not suitable to electrify but htsw designs can be made more effective. For instance, a 5 strand game fence is shown modified for use with either fallow deer, reindeer or bison on page 9.

Comments on Electric Fence Design Information

Both permanent and temporary fences are outlined in the following designs. As the conductance of the ground varies with moisture content, circuits for both dry and moist (irrigated or greater than 24 inch precipitation) ground conditions are shown. Because frozen or snow covered ground has low conductance, use the low moisture designs for electric fences in winter. In the following figures:

- + = positive electrical charge
- = negative electrical charge or ground
- = insulator (for + wires)
- / = staples (for - wires)

Tensioners are optional in the following designs because of the low wire tension required in electric fences.

Detailed designs and specifications are located on the following pages for the main agricultural electric fences as listed below.

Table 1 Guide to Electric Fence Designs			
	Permanent Electric High Tensile Smooth Wire		Temporary electric Light Steel or Polywire
Cattle	4-strand 3-strand 2-strand	pg. 3 pg. 4 pg. 5	1- & 2-strand pg. 6
Sheep	4-strand 3-strand	pg. 7 pg. 7	2-strand pg. 8
Fallow Deer/Reindeer/Bison	5-strand	pg. 9	

PERMANENT ELECTRIC FENCE DESIGNS FOR CATTLE

- USE: cattle, perimeter; medium pressur
- WIRE: 4 strands, htsw
- *POSTS: spaced 30 feet
- HEIGHT: 39 inches
- DROPPERS: none
- *BRACES: spaced up to 1320 feet (4 per mile)
- NOTES: Standard cattle permanent electric boundary fence

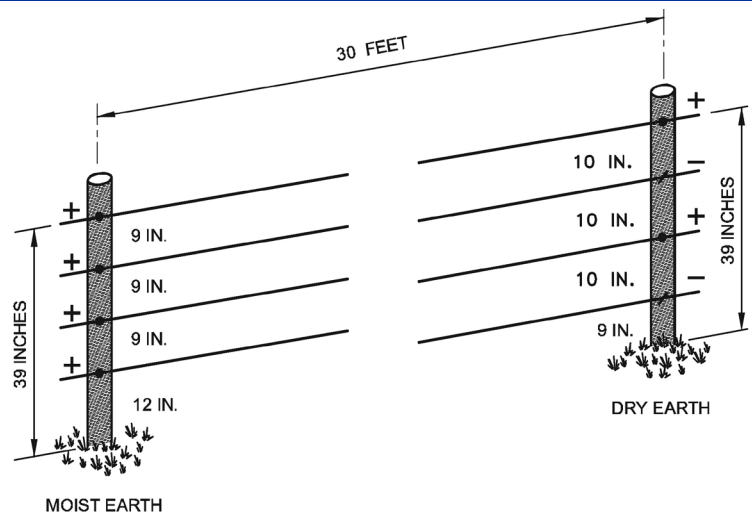


Figure 1 Permanent Electric Four-Strand Cattle Perimeter Fence

Materials Required per Mile*		Description
Wire	5.7 rolls	- single strand htsw, 3,750 ft per 100 lb roll - 12½ ga, Class 3 galvanizing (standard) - 1,350 lb breaking strength (min) - tensioned to 150 lb
Line Posts	*176	- 2 to 3 inch diameter x 6 feet long - pressure treated, pointed, domed - driven 2 feet (min)
Brace Posts	*8	- 3 to 4 inch diameter x 7 feet long (2 per brace) - pressure treated, pointed, domed - driven 3 feet (min)
Brace Rails	*4	- 3 to 4 inch diameter x 8 feet long (1 per brace) set at ¾ brace height
Staples 2 wire: 1/8 box		- for grounded wires (if used) - 1¾ inch, slash point, hot dip galvanized - angled across post grain by rotating away from the slash point - not driven home on line posts
Tensioners	16	- 1 per strand per brace section
Line Insulators	4 wires: *704 2 wires: *352	- for electrified wires (4 or 2 wires) - plastic material, strong - nail or screw onto post - have long “shorting” distance - easy to replace
Tie-off Insulators	4 wires: *32 2 wires: *16	- two per wire per braced section (8 per strand mile) - also required at change of directions



* per mile of level terrain—rough terrain may require more posts, braces and insulators

USE: cattle, cross fence, medium pressure

WIRE: 3 strands, htsw

*POSTS: spaced 30 to 75 feet

HEIGHT: 36 inches

DROPPERS: none on 30 to 50 feet
1 on 50 to 75 feet
post spacing designs

*BRACES: spaced up to 1320 feet
(4 per mile)

NOTES: About $\frac{1}{2}$ to $\frac{1}{3}$ material cost
of nonelectric designs for
cross fencing

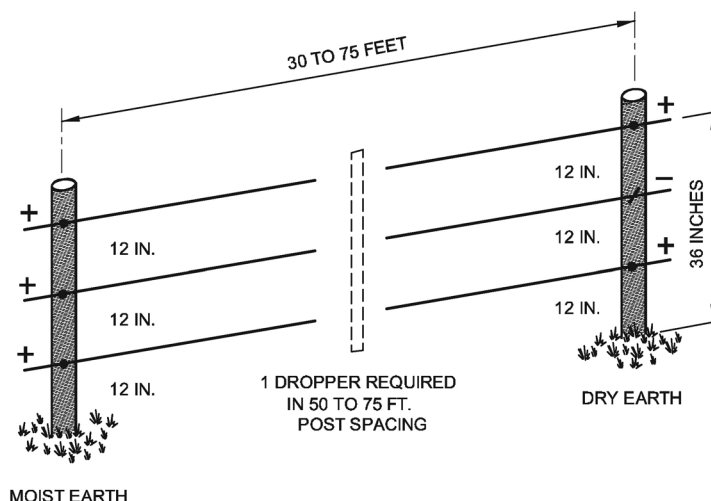


Figure 2 Permanent Electric Three-Strand Cattle Cross Fence

Materials Required per Mile*

Description

Wire	4.3 rolls	- single strand htsw, 3,750 feet per 100 lb roll - 12½ ga, Class 3 galvanizing (standard) - 1,350 lb breaking strength (min) - tensioned to 150 lb
Line Posts	30 ft: *176 75 ft: *71	- 2 to 3 inch diameter x 6 ft long - pressure treated, pointed, domed - driven 2 ft (min)
Brace Post	*8	- 3 to 4 inch diameter x 7 feet long (2 per brace) - pressure treated, pointed, domed - driven 3 feet (min)
Brace Rails	*4	- 3 to 4 in diameter x 8 feet long (1 per brace) set at $\frac{3}{4}$ brace height
Droppers	50 ft: 106 75 ft: 71	- non-conducting material such as polyethylene pipe
Staples	1 wire: 1/16 box	- for grounded wire (where used) - 1¾ in, slash point, hot dip galvanized - angled across post grain by rotating away from the slash point - not driven home on line posts
Tensioners	12	- 1 per strand per brace section
Line Insulators	3 wires: 30 ft *528 75 ft: *213 2 wires: 30 ft *352 75 ft: *142	- for electrified wires (3 or 2 wires) - plastic material, strong - nail or screw onto post - have long “shorting” distance - easy to replace
Tie-off Insulators	3 wire: *24 2 wire: *16	- two per wire per brace section (8 per strand mile) - also required at change of direction

* per mile of level terrain—rough terrain may require more posts, braces and insulators

USE: cattle, cross fence; low pressure

WIRE: 2 strands, htsw

*POSTS: spaced 30 to 75 feet

HEIGHT: 28 inches

DROPPERS: none on 30 to 50 feet
1 on 50 to 75 feet
post spacing designs

*BRACES: spaced up to 1320 feet
(4 per mile)

NOTES: About $\frac{1}{2}$ to $\frac{1}{3}$ material cost
of nonelectric designs for cross fencing

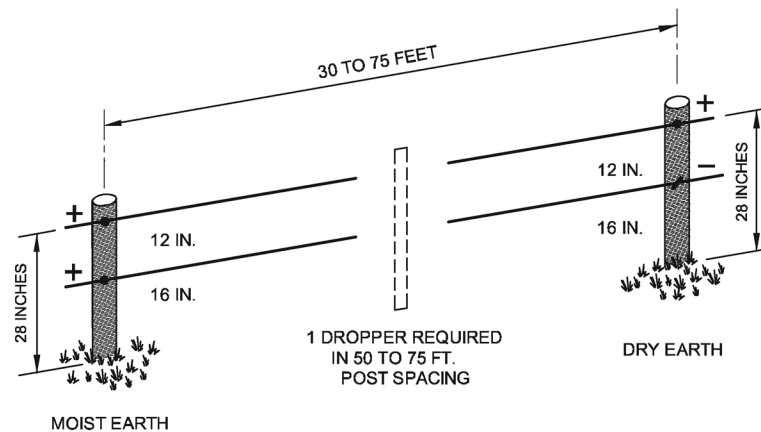


Figure 3 Permanent Electric Two-Strand Cattle Cross Fence

Materials Required per Mile*		Description
Wire	2.9 rolls	- single strand htsw, 3,750 feet per roll - 12½ ga, Class 3 galvanizing (standard) - 1,350 lb breaking strength (min) - tension to 150 lb
Line Posts	30 ft: *176 75 ft: *71	- 2 to 3 inch diameter x 6 feet long - pressure treated, pointed, domed - driven 2 feet (min)
Brace Posts	*8	- use line posts as above - driven 3 feet (min)
Brace Rails	*4 brace rails	- use line posts as above; set at $\frac{3}{4}$ brace height
Droppers	50 ft: 106 75 ft: 71	- non-conducting material such as polyethylene pipe
Staples	1 wire: 1/16 box	- for grounded wire (where used) - 1¾ in, slash point, hot dip galvanized - angled across post grain by rotating away from the slash point - not driven home on line posts
Tensioners	8	- 1 per strand per brace section
Line Insulators	2 wires: 30 ft *352 75 ft *142 1 wire: 30 ft *176 75 ft *71	- for electrified wires (2 or 1 wire) - plastic material, strong - nail or screw onto post - have long “shorting” distance - easy to replace
Tie-off Insulators	2 wires: *16 1 wire: *8	- two per wire per brace section (8 per strand mile) - also required at change of directions

Note: In dry earth conditions the wires may be reversed; i.e., + for bottom wire and - for top wire.

* per mile of level terrain—rough terrain may require more posts, braces and insulators.

TEMPORARY ELECTRIC FENCE DESIGN FOR CATTLE

- USE: cattle, movable grazing control; low to medium pressure
- WIRE: 1 or 2 strands htsw or polywire
- *POSTS: spaced 30 feet
- HEIGHT: 28 inches
- DROPPERS: none
- BRACES: none – tie off onto perimeter fence post
- NOTES: Minimal fence for control of grazing cattle. Moist earth required as no ground return wire is used. See below.

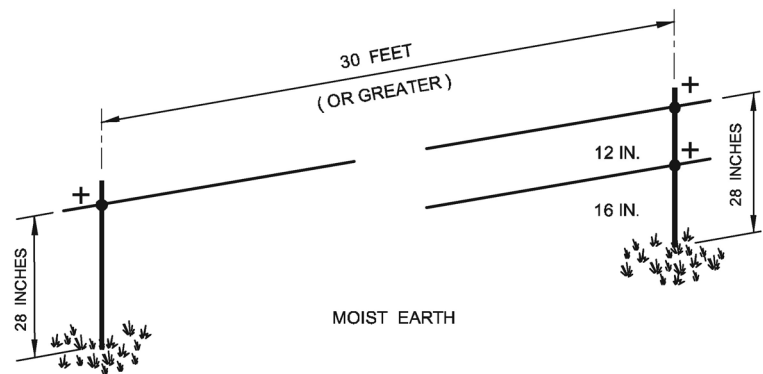


Figure 4 Temporary Electric One- or Two-Strand Cattle Cross Fence

Materials Required per Mile*		Description
Wire	2 strand: 10,600 feet	- standard 12-1/2 ga htsw, 16 or 17 ga htsw, or polywire
	1 strand: 5,300 feet	- low (hand pull) tension
Line Posts	*176	- “push-in” type fibreglass, or 3/8 inch steel rebar x 3 feet long
Insulators	2 strand: *352	- one per wire per post if steel rebar posts are used
	1 strand: *176	- none required with fibreglass posts
Wire Reels	1 or 2 reels	- one per wire strand
		- allows windup for easy moving

Note: This two wire design is not given with the ‘dry earth’ option. The light duty materials used for portability should have the good circuit conditions of moist earth.

* per mile of level terrain—rough terrain may require more posts and insulators.

PERMANENT ELECTRIC FENCE DESIGNS FOR SHEEP

USE:	sheep, perimeter; medium pressure
WIRE:	4 strands, htsw
POSTS:	spaced 30 feet
HEIGHT:	32 inches
DROPPERS:	none
BRACES:	spaced up to 1320 feet (4 per mile)
NOTES:	Standard design for perimeter fence. Materials description and required per mile as for Cattle 4-Strand Permanent design; see Figure 1.

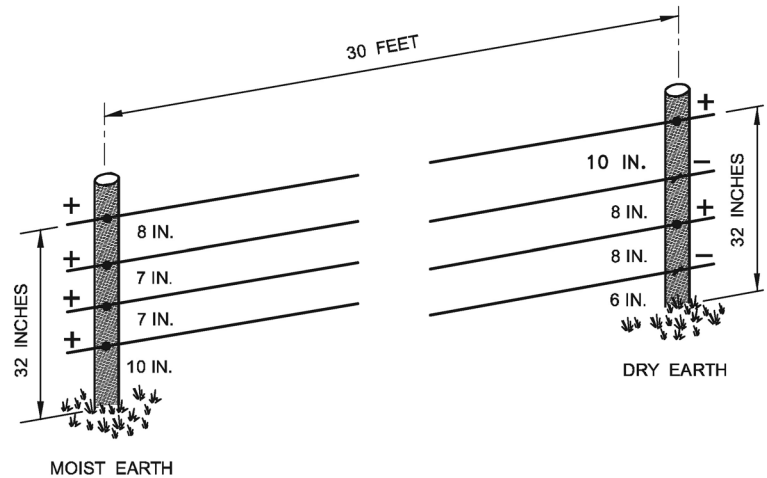


Figure 5 Permanent Electric Four-Strand Perimeter Fence

USE:	sheep, cross fence; medium pressure
WIRE:	3 strands, htsw
POSTS:	spaced 30 to 75 feet
HEIGHT:	30 inches
DROPPERS:	1 on 50 to 75 feet Post spacing designs
BRACES:	spaced up to 1320 feet (4 per mile)
NOTES:	Standard design for perimeter fence. Materials description and required per mile as for Cattle 3-Strand Permanent design; see Figure 2.

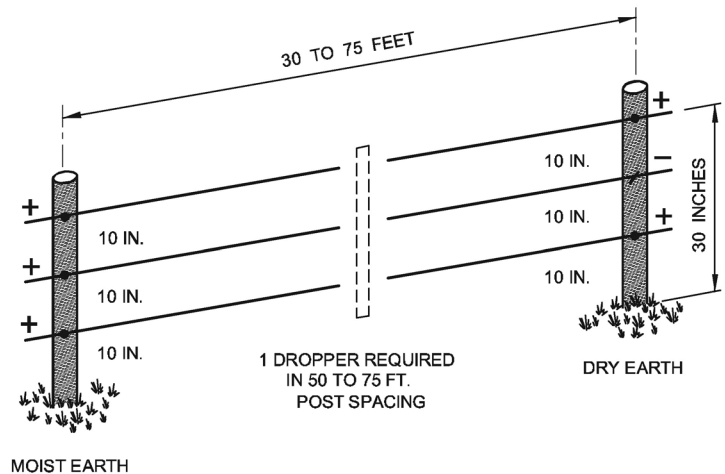


Figure 6 Permanent Electric Three-Strand Sheep Perimeter Fence

TEMPORARY ELECTRIC FENCE DESIGN FOR SHEEP

USE	sheep, movable Grazing control: Low to medium pressure
WIRE:	2 strands htsw or polywire
POSTS:	spaced 30 feet
HEIGHT:	24 inches
DROPPERS:	none
BRACES:	none – tie off onto Perimeter fence post
NOTES:	A temporary movable sheep fence can also be constructed using “poly” netting rather than poly strands. Minimal fence for control of grazing sheep. Materials description and required per mile as for Cattle – 2-Strand Temporary. See Figure 4.

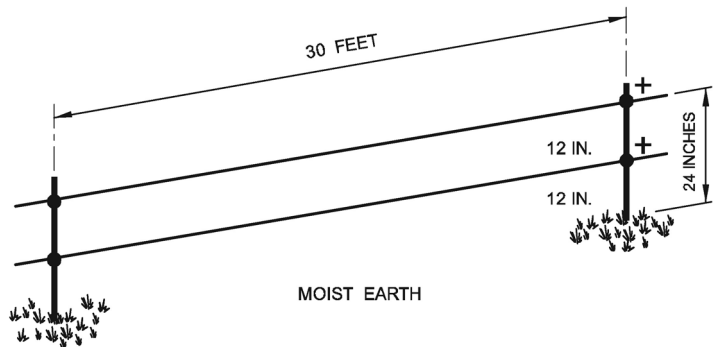


Figure 7 **Temporary Electric Two-Strand Sheep Cross Fence**

PERMANENT ELECTRIC FENCE DESIGN FOR GAME

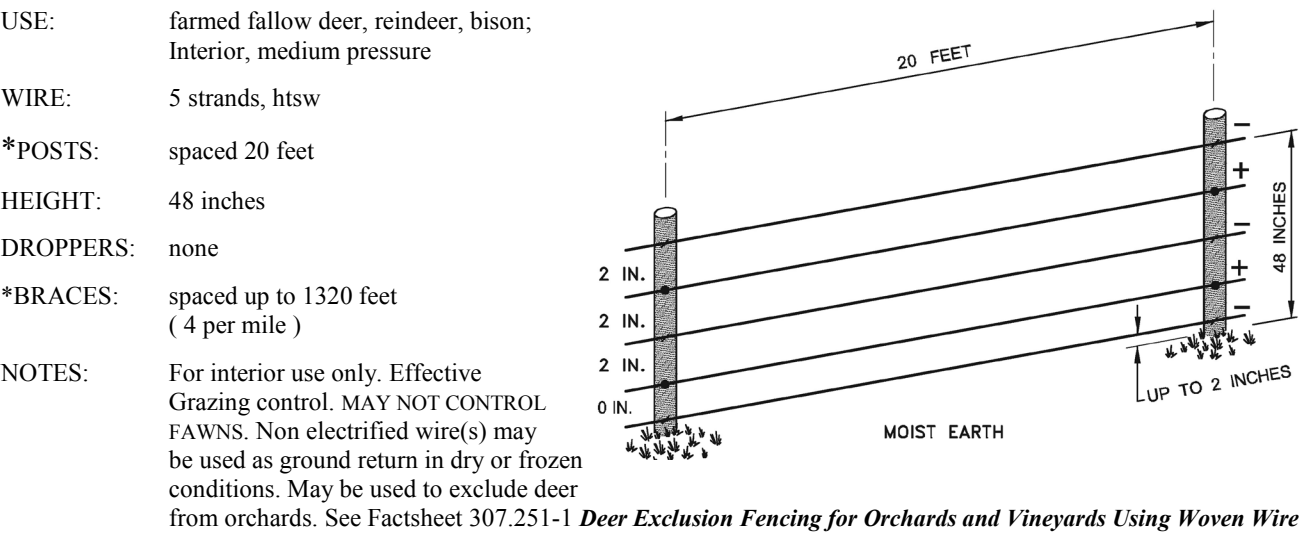


Figure 8 Permanent Electric Five-Strand Game Cross Fence

Materials Required per Mile*		Description
Wire	8.5 rolls	- single strand htsw, 3,750 feet per 100 lb roll - 12½ ga, Class 3 galvanizing (standard) - 1,350 lb breaking strength (min) - tensioned to 250 lb
Line Posts	*264	- 3 to 4 inch diameter x 7 feet long - pressure treated, pointed, domed - driven 2½ feet (min)
Brace Posts	*8	- pressure treated, pointed, domed - driven 3½ feet (min)
Brace rails	*4	- 3 to 4 inch diameter x 10 feet long (1 per brace) - optional 8 feet long set down to ¾ of brace height
Staples	1/3 box	- for grounded wires (3 wires) - 1¾ in, slash point, hot dip galvanized - angled across post grain by rotating away from the slash point - not driven home on line posts
Line Insulators	*528	- for electrified wires (2 wires) one per wire per post - plastic material, strong - nail or screw onto post - have long “shorting” distance - easy to replace
Tie-off Insulators	*16	- two per wire per brace section (8 per strand mile) - also required at change of direction

* per mile of level terrain—rough terrain may require more posts, braces and insulators



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PASTURE FENCING FOR HORSES

This factsheet outlines various permanent, non-electric fence designs to contain horses on pastures. Wood, strand wire, woven wire, PVC and polymer-based materials are discussed.

A large percentage of horse injuries that occur on farms are fence related and may be as a result of the fence materials, the fence design, the workmanship, or combinations of all three. While a horse fence may simply be a modified cattle design (for example more wire strands and a higher overall height), the most successful horse fences are designed and built with specific horse habits in mind:

- The tendency to get hooves and legs caught in or through the fence or brace assembly.
- The habit of chewing wood boards.
- The need for good fence visibility.

Upgrading existing fences is only to be considered where the fence is not badly aged or in need of extensive repairs. New construction is otherwise preferred.

The following discussion assumes construction of a new permanent horse fence.

Planning, as in any construction project, is the first step:

- Sketch the area showing fence and gate locations.
- List the constraints (i.e. topography, vegetation, soil type, etc.).
- Where required, accurately identify property boundaries.

- Decide on permanent or temporary fence needs.
- Decide on electric, nonelectric or combinations thereof.
- Do you require additional aesthetic values?
- Do you have a material preference?
- Establish a budget range; will you do the labour?

Fence types vary from all wood, all steel wire, polymer, PVC, or combinations of these materials. Designs using these materials vary from large pastures (low fence pressure) to small corrals (high fence pressure). Barbed wire may be a poor material to use for horse fences (especially for high-value animals) and should not be electrified.

Electric fences can be used either alone or in conjunction with non-electric fences. An electric fence is a psychological rather than a physical barrier that must be constructed as both a fence and an electrical circuit. An all-electric fence may have poor visibility and be a problem with some horses. One electric wire used on a non-electric fence can give good control with good visibility and keep horses from pressuring fences. As with other livestock, horses must be trained to an electric fence, but as they are sensitive to electricity, this is not difficult.

Temporary or movable electric fences are used if grazing control is desired within a fence pasture. Easy to use “polywire” is used for temporary fences or standard steel smooth wire.

Steel fence panels can be used in high-pressure situations when temporary or movable containment is required. Panels 10 ft by 5 ft high (80 lb) link together in a self supporting system.

Permanent fences should be installed only after good planning to limit future concerns especially property boundary fences. Seven types of permanent fence are discussed in the following pages (see Table 1 at the end of this Factsheet for a quick comparison).

1 All wood fences, consisting of treated wood posts and round or board rails, are common in British Columbia. With quality materials and construction, wood fences are effective. Chewing of the rails, especially the top rail, is a problem for both fence life and horse health. An electric wire spaced away from the rail can reduce chewing.

Wood fences are used in all pressure situations, but are most commonly used in high-pressure locations such as corrals. The material cost of the rails may vary greatly. Expect medium to high maintenance and repainting costs. See Figure 1 for typical all wood designs using planks.

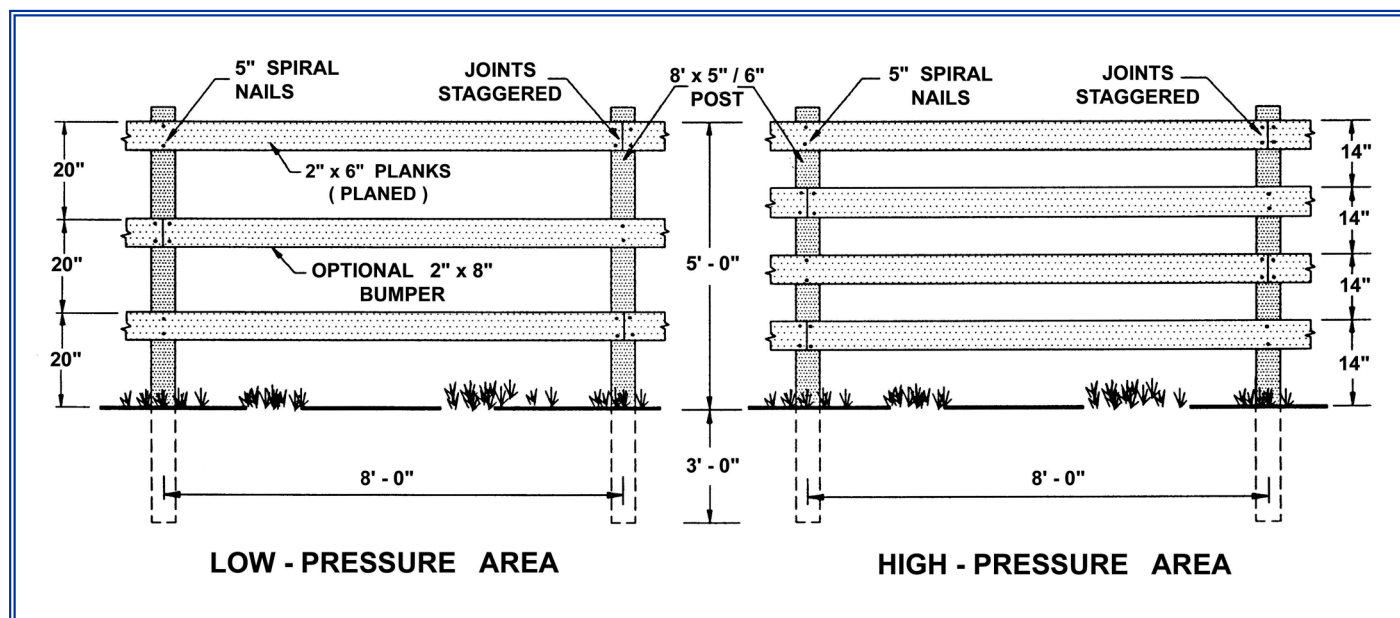


Figure 1

Typical All Wood Plank Fences

2 Wood posts/steel strand wire fences are also very common, and are most effective in low-pressure pasture situations. Barbed wire and high-tensile smooth wire are common steel fence wires. These fence designs are often modified cattle fences. See Figure 2.

3 Wood posts/steel woven wire fences are effective in horse control with various wire designs available. Woven wire options are varied but two features should be carefully selected.

- First, use woven wire with continuous verticals. This is important for a quality fence. Choose either:
- Knotted joint wire – one piece verticals with separate knotting wire at all the joints to horizontals, or:
- Mesh type wire – one-piece verticals that are linked or twisted at the joints to horizontals.

The least desirable woven wire is the hinged joint type that has separate vertical pieces twisted together (they can come apart), or welded joint wire (no flexibility).

Secondly, select woven wire by the size of the openings. Because horses will put their hooves through openings or “walk down” the fence, choose woven wire with an opening dimension small enough to prevent this from occurring.

Woven wire in a diamond mesh, a 2” by 4” rectangular opening, or a polymer grid fabric should be selected. See Figure 3. Standard farm woven fence with larger openings is not recommended for most horse pastures.

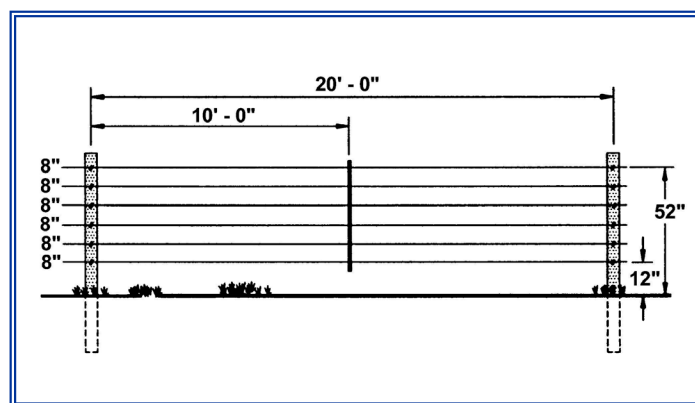


Figure 2 Typical Wood Post/Wire Strand Fence

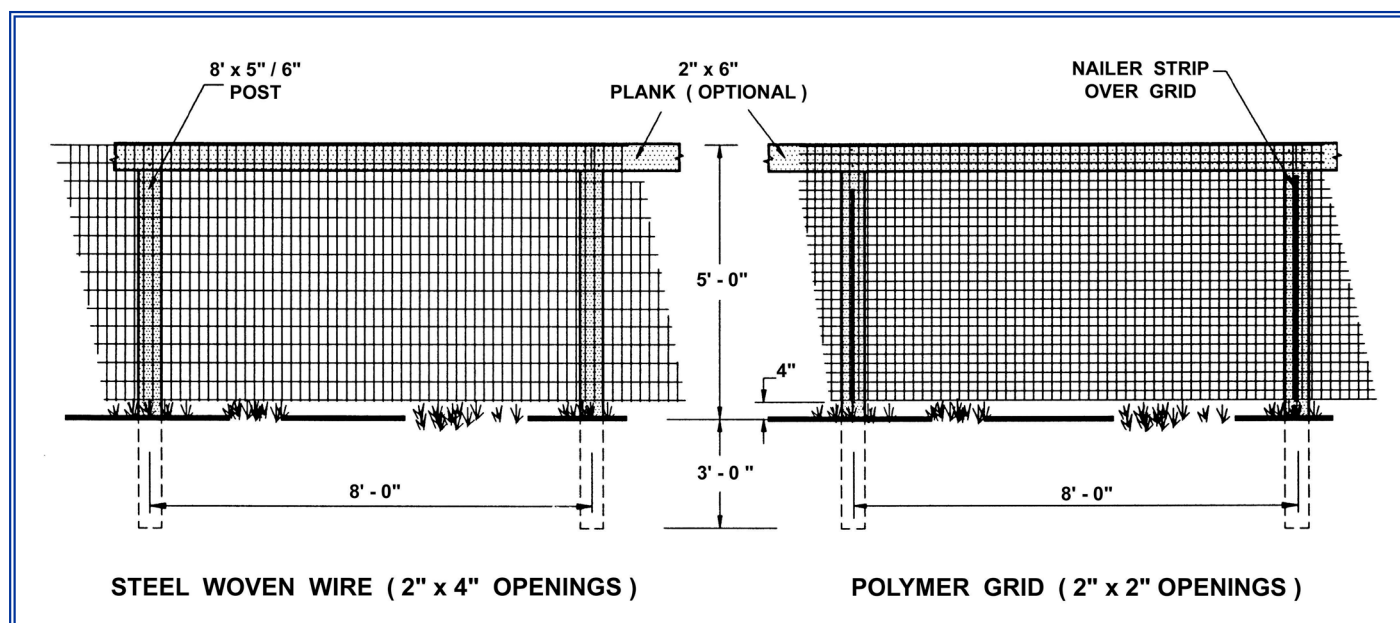


Figure 3 Typical Steel Woven Wire and Polymer Grid Fences

4 Wood posts/polymer coated steel wire fences are relatively new to British Columbia. They consist of steel wire coated in a polymer (usually white) available as either a single strand (to replace single strand steel wire) or in a “rail” consisting of two or three steel wires spaced 4” or 5” apart and covered in a polymer coating (to replace wood rails or boards).

This material combines the strength of steel, the low maintenance of polymer with the visibility and the aesthetic value of white rail fences. The rail product is sold as “Centaur HTP Fencing Systems” (high-tensile polymer) and the single strand wire as “Equi-Wire.” Both are available in British Columbia. It is sometimes considered an “estate” fence rather than a common farm fence because of its high aesthetic value.

5 Wood post/all polymer strand fences are recently becoming popular in British Columbia, partly due to their low maintenance and high aesthetic value. This monofilament is a heavier gauge than most steel fence wire (8.5 gauge compared to 12.5 gauge) and has a breaking strength slightly greater than standard barbed wire but less than high-tensile wire. It is single strand solid polymer, white in colour that produces an attractive, highly visible fence.

This monofilament is easy to handle and is joined by knotting. It is stapled “tight” to the fence post unlike steel wire. These fences are otherwise similar to other wood post/steel wire horse designs in the number and spacing of strands and the overall height as shown in Figure 2. The monofilament is sold as “Bayco Fencing” in B.C. It could also be considered an “estate” fence.

6 Wood posts/all polymer grid fences are relatively new to British Columbia but are a proven product that is quite “horse safe.” This polymer is produced in a grid format that has 2” by 2” openings (5 ft height typical for horses). It is stretched and attached with nailing strips to wood posts. Horses are said not to chew the poly-grid, but a wood top rail or an electric wire can be used. See Figure 3 for a typical design.

The polymer grid products are available in various qualities depending on the type of material and whether the fabric was “stretched” during manufacture (producing greater web strength) and

whether it was stretched in two directions (greatest strength). Generally, cost is proportional to strength. As with other polymer fence products, low maintenance, good visibility, horse safe, aesthetic value and durable colour (usually black or white) are advantages.

7 All poly vinyl chloride (PVC) fences are relatively new to British Columbia. This product is designed to imitate the wood post/wood rail traditional horse fence using long lasting, low-maintenance PVC. These fences have high aesthetic value and could also be considered an “estate” fence.

Pasture fence layout is important:

- Ensure good fence visibility.
- Allow adequate room for horses to run for exercise.
- Keep corners to a minimum.
- Consider “rounding” corners.
- Allow for separate pastures for “difficult” horses.
- Locate gates for good access and horse movement.

Gates in horse pastures require adequate strength, either steel pipe or sturdy wood planks or rails. Some lightweight formed metal gates may not stand up to horse pressure. Choose secure latches (“horse proof”). Consider ease of operation and whether a gate must be opened from horseback.

Cattleguards in place of horse gates are generally not preferred. Horses may jump standard cattleguard widths or may catch their hooves in the open spaces.

Brace assemblies are required for all horse fence types except the all wood rail and all PVC rail designs. A brace is the anchor point for the wire strands, woven wire or grid that forms the fence.

Braces must be constructed to withstand the loads due to the material tension as well as loads due to the horse pressure against the fence. Figure 4 is a typical end brace using a horizontal rail pinned to the driven posts with two 3/8” rebar pins. Two wraps of brace wire (using high-tensile wire) complete the brace.

While this design is structurally sound, problems can occur where space between the brace wire and the fence wire can trap a horse’s leg. To prevent this, block off this space on all braces accessible to a horse’s leg. If using woven or grid wire, wrap the brace on both sides.

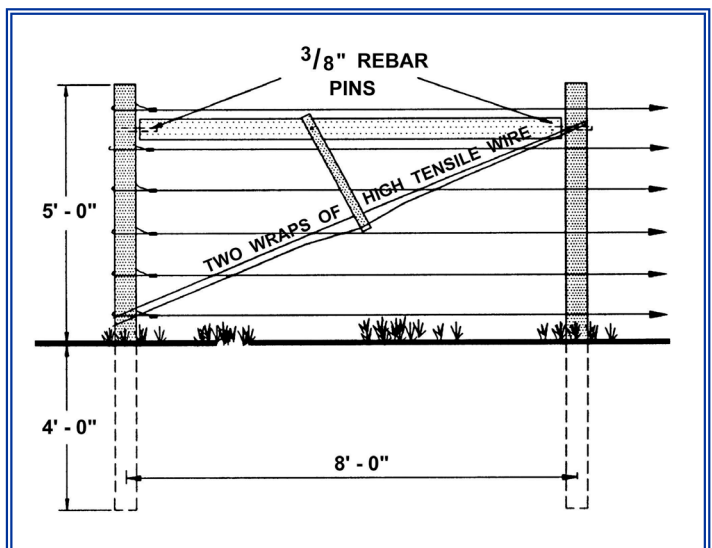


Figure 4 End Brace Assembly

TABLE 1 TYPES OF HORSE FENCES (PERMANENT, NONELECTRIC)								
(Refer to text for detailed information)	RAIL FENCE			SEPARATE STRAND FENCE			WOVEN or GRID FENCE	
	WOOD POST		PVC POST	WOOD POST			WOOD POST	
	WOOD RAIL	POLYMER / STEEL RAIL	PVC RAIL	STEEL WIRE	POLYMER / STEEL WIRE	ALL POLYMER STRAND	STEEL WOVEN	POLYMER GRID
Chew?	yes	no	no	no	no	no	no	no
Catch hooves?	no	no	no	no	no	no	may ¹	no
Catch legs?	no	no	no	may ²	may ²	may ²	may ¹	no
Visibility	good	good	good	poor ³	fair	fair	good	good
Colour	painted	white or black	white	steel	white	white	steel	black or white
Maintenance	high	low	low	medium	medium	medium	low	low
Aesthetics ⁴	medium to high	high	high	low	medium to high	medium to high	medium	medium to high
Relative Cost	low	high	highest	lowest	medium	medium	high	highest

1. Choose small opening woven wire.
2. All separate wire fences have the possibility of tangling horse legs.
3. Steel wire strands (12.5 gauge commonly used) have the least visibility.
4. This factor is, of course, personal and subjective.

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Fencing FACTSHEET



Order No. 307.271-1
Revised December 2015

DEER FARM PERIMETER FENCE

This factsheet outlines construction information for woven wire perimeter fences for fallow deer and reindeer farms. The fence design is the standard required for a game farm license in British Columbia.

INTRODUCTION

Woven wire and high-tensile, smooth wire (htsw) are the preferred products for fencing deer. Barbed wire is not used except for special predator problem areas. Provincial permit regulations require woven wire for perimeter fences, while internal fences are not regulated. Electric fencing has an important role in both types of fences. In deer handling areas and milling yards, wood batten fencing should be used to restrict visibility, thereby improving handling.

EXTENDING EXISTING FENCES

There are three concerns in converting existing fences for use as a deer farm perimeter fence:

- Will the extensions have adequate strength?
- Can the connection to the post be made adequately?
- Are the existing posts set in the ground adequately?

The first two points can be met, but post depth is usually not sufficient in existing fences. For a seven-foot fence, line posts must be in the ground two and one-half to three feet.

PERIMETER FENCE DESIGN

Provincial regulations require a seven-foot high fence, all of which must be woven wire. Shown below is a design using woven wire with graduated openings.

Note: Knotted-joint style woven wire is required on perimeter fences with 6-inch vertical wire spacing. The bottom three feet must have wire openings small enough to contain fawns.

Additions can be made to these two designs for added control:

- Additional top wires for added height or tighter spacings. One or more strands of htsw may be used above the woven wire in areas of high deer pressure (e.g., where the perimeter fence also serves as one side of a mustering area or alley).
- Electrified offset wire(s), either inside at 24 to 30 inches high or outside at predator height

WOVEN WIRE PERIMETER FENCE FOR FALLOW DEER AND REINDEER FARMS

Total Height	- 84 inch (min.) knotted joint style
Horizontal wires	- 18 wires, 12 ½ ga., high tensile, graduated openings tighter at the bottom half of fabric
wire spacing	- graduated from 3 inch (bottom) to 7 inch (top).
Vertical wires	- 12 ½ ga., medium tensile
wire spacing	- 6 inch (fallow) 12 inch (reindeer)

- Electrified htsw top wire(s) for extra predator control.
- Electrified offset wire(s), either inside at 24 to 30 inches high or outside at predator height.
- One outside barbed wire at ground level to resist any digging predators.
- An extra piece of woven wire (one or two feet) buried and attached to the bottom of the fence wire to resist any digging predators. This will be awkward to do and wire corrosion may limit the life expectancy. Pressure-treated wood boards are an alternative.
- Wood battens or other materials attached to the woven wire to increase fence visibility in areas of concern, often to aid deer mustering.

These additions can be used depending on the individual farm needs. See Figure 1 for a woven wire fence with one electric offset wire and one extra top wire.

TYPES OF WOVEN WIRE

Various types of joints are used where horizontal and vertical wires cross. Only hinged joint and knotted joint are suitable for fencing; **only knotted joints** are suitable for perimeter fencing for fallow deer and reindeer farms.

A **hinged joint** (Figure 2) is made with separate short lengths of stay wire twisted together at the horizontal wire. This is a flexible wire fabric; however, the wire wrap can come loose under pressure allowing the stay wire to slip sideways.

A **knotted joint** (Figure 3) is made with a one-piece, continuous stay wire and a separate knotting wire. This joint is strong and secure.

Knotted-joint woven wire is the only choice for perimeter fences because of the extra security of the joints. Both types may be used for interior fences.

INSTALLING WOVEN WIRE

The following points are important when installing woven wire fences:

- Place the wire on the animal side of the line posts (but on the outside of posts when turning corners).

Ensure the wire is flush with the ground and there are no gaps due to terrain irregularities. Deer will



Figure 1 Deer Exclusion Fence

go under a fence if it is possible. A well-prepared right-of-way is important

- Mechanical splices for woven wire are made the same as individual wires. This is the preferred method of joining woven wire.
- Woven wire can also be joined with wrap splices by leaving four to six inches of line wire beyond the end stay. Lay together the end stay wires of each of the two sections to be spliced, then wrap the free ends tightly around the line wire and wrap the ends back onto themselves as in Figure 4.



Figure 2 Hinged Joint

- Tension woven wire to remove only one-third to one-half of the tension curve from the line wires. See Figure 5.
- Tensioning may be done from the end post (then stapling wire tight onto the brace post), or from a braced dummy post set six to eight feet beyond the brace. Never use a tractor for tensioning because of the operator hazards and possible over-tensioning.
- When tying off woven wire at the end brace, take the free end of each line wire around the end post and wrap it on itself. See Figure 6. Do not depend on staples to hold the fence wire tension.
- Do not "drive" the staples "home" on line posts. The wire should be free to move.
- For maximum pullout resistance, staples should be rotated so as to cross the grain of the post (reducing post splitting), and to ensure the two legs of the staple spread out and away from each other.
- * Individual htsw strands are tensioned to 200 pounds.

PERIMETER FENCE LINE POSTS

Whichever wire configuration is used, the following is recommended for posts (all posts must be pressure-treated for long life):

- Line Posts: *4"/5" by 10' long set 2 ½' into the ground and spaced up to 15' apart (up to 20' apart in firm, level terrain).

* 4"/5" indicates a 4-inch to 5-inch diameter post.

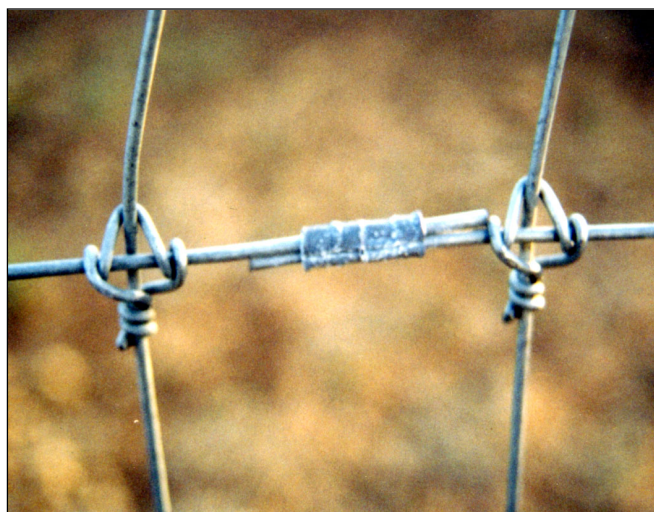


Figure 4 Splicing Woven Wire

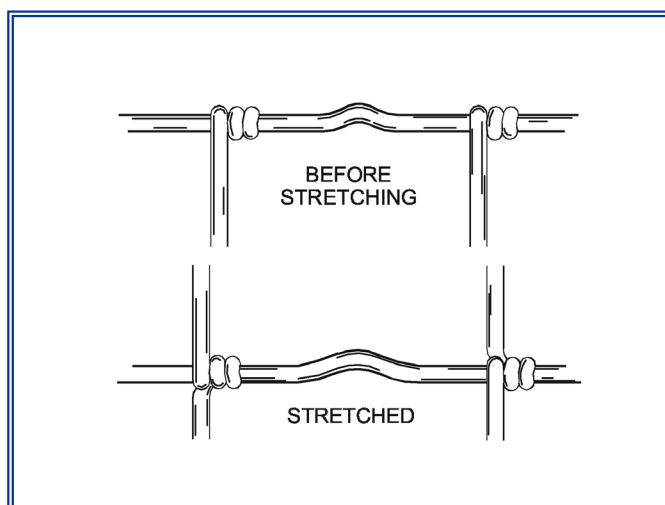


Figure 5 Tensioning Woven Wire

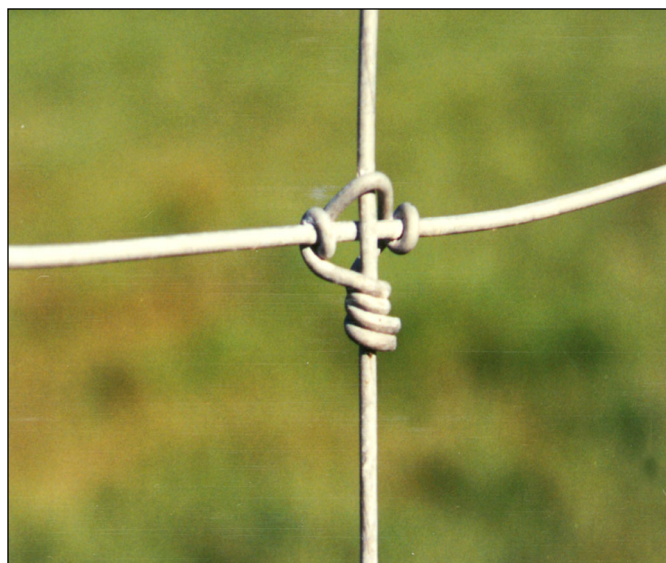


Figure 3 Knotted Joint



Figure 6 Tying Off Woven Wire (top view)

PERIMETER FENCE BRACE ASSEMBLIES

Figure 7 illustrates good end brace construction. Note the horizontal rail is not notched into the driven posts but is connected using 1/2" rebar into pre-drilled holes.

End Braces: Two posts @ 5"/6" by 11' long set 4' into the ground. One horizontal rail @ 4"/5" by 10' long. This single-span brace is sufficient for most conditions but in poor areas (sandy soil, wet areas, etc.), use a double-span brace assembly. This has three driven posts and two rails with the wire tie-off on the centre post.

Corner Braces: For 90° corners, use a brace of three driven posts and two rails. Tie off both woven wires at the corner post or continue the wire around the outside of the brace.

Note: Braces can be set up to 660 feet apart.

ELECTRIC FENCE WIRES

Electric fences are very effective for internal fences. On perimeter fences, electric wires can be used for added control (see *Perimeter Fence Design*, page 1). Animals require training at first, but quickly learn to respect the electric "bite." Because you are constructing an electric circuit, pay close attention to insulation, all wire connections, and especially wire grounding. Problems in electric fences are often due to poor grounding.

Note: For safety reasons, do not electrify barbed wire.

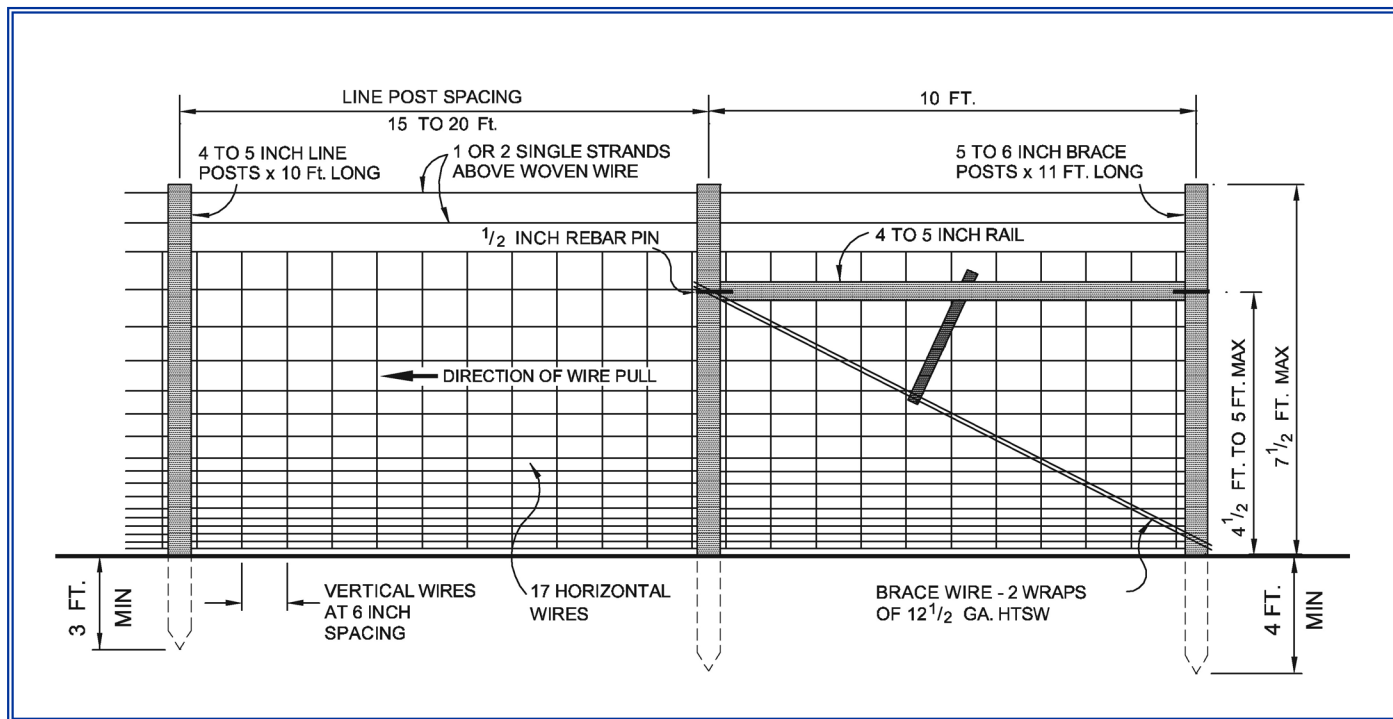


Figure 7 Perimeter Fence and End Brace Design

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Fencing FACTSHEET



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INTRODUCTION TO ELECTRIC FENCING

This factsheet outlines the basics of electric fencing, the materials used and some circuit fundamentals.

GETTING STARTED

Electric fences are commonly used in agriculture. Whereas standard fences are constructed to form a **physical** barrier, electric fences are constructed to form a **psychological** or mental barrier. The mental barrier is accomplished by introducing an electric shock through the fence wire that both repels the animal and makes them less likely to contact the fence again. Once the animal has been electrically shocked it will remember the discomfort and learn to avoid the fence.

Electric fences may be less robustly constructed using lower cost materials than nonelectric fences, but to be effective they must have:

- the physical structure (i.e., the posts and wire)
- the electric circuit (i.e., a complete path for the current)
- proper maintenance to ensure the circuit is not “shorted out”

There are two types of electric fences: temporary and permanent. Both require a fence controller to energize the fence.

Safety Considerations

Electricity must be respected at all times. To ensure the safe installation of an electric fence:

- use only fence controllers approved by the Canadian Standards Association (CSA) when using plug-in types
- for plug-in-type controllers, ensure an electrical inspector has inspected the electrical supply service
- use battery controllers from reputable companies (note that there are no standards or regulations regarding these controllers)
- install the controller according to the manufacturer’s recommendations
- check with local governments for restrictive bylaws that may affect an electric fence
- check with your farm insurance company regarding liability coverage for an electric fence. Because negligence usually must be proven, liability should not typically be a concern for properly-installed electric fences.
- install warning signs on the fence to warn the public. Plastic signs that clip onto the fence wire are readily available.

Because animals (or humans!) may be caught and tangled in barbed wire, it is advised to avoid using barbed wire for electric fences. If an animal or person is not able to separate from an energized electric fence, serious damage, possibility death, will occur.

Advantages of Electric Fences

Electric fences have a number of advantages over non-electric fences, including:

- a possible improvement in livestock control
- possible lower construction costs for both materials and labour
- temporary fence configurations are easily moved for grazing control, for example
- they may be effective in controlling wildlife and predators
- they can be used to extend the life of existing non-electric fences
- they may reduce the livestock pressure on other farm fences (even fences which are non-electric)

Disadvantages of Electric Fences

The following points should be considered when choosing to use an electric fence:

- the fence is (or may be) ineffective if the power is off or grounded out
- more frequent inspections and maintenance may be required
- special designs are required in dry, frozen or snow-covered soil conditions
- training of animals to become familiar with and gain respect for the fence should be done prior to turning the animals out
- fenceline weed control is important to reduce shorting of the electrical circuit
- it may be difficult to convert to a non-electric fence if lightweight materials were originally utilized
- usually not suitable for confined areas or where animals are in crowded conditions

Permanent Electric Fences

There are two main uses of permanent electric fences:

- those used for additional livestock control for which one or more electrified wires are added to a non-electric design), or
- those used for low-cost basic livestock control as in, for example, in fixed grazing subdivisions

Neither of these take advantage of the portability of electric fences but emphasize their attributes of creating a psychological deterrent to either improve control or reduce costs compared with a permanent fence.

Temporary Electric Fences

These take full advantage of the portability features of electric fences by using light steel wire or a polyethylene/steel composite wire material (cord, tape or netting) along with lightweight, hand-installed posts. Easily moved and set up, these fences are used for temporary holding, rotational grazing or other similar situations.

UNDERSTANDING ELECTRICITY

To properly install and maintain an electric fence, an understanding of the principles of electricity is important. The following is a simplified look at electricity.

Electricity is the flow of electrons. In fence applications, that flow may be in a wire or in the earth between grounding points. This flow cannot be seen but can be felt!

Comparison to Water Systems

It is often easiest to “visualize” electricity in terms of water. Both need a conduit to move (water in a pipe or electricity in a wire); both can be stored (water in a tank or electricity in a battery); and neither can be compressed (if you increase the pressure at one end of a system it results in increased pressure at the other end).

Figure 1 further illustrates these similarities. The water system contains water from a tank pumped under pressure through a pipe. The electrical system supplies electrons from a battery or utility lines forced down a wire by a controller.

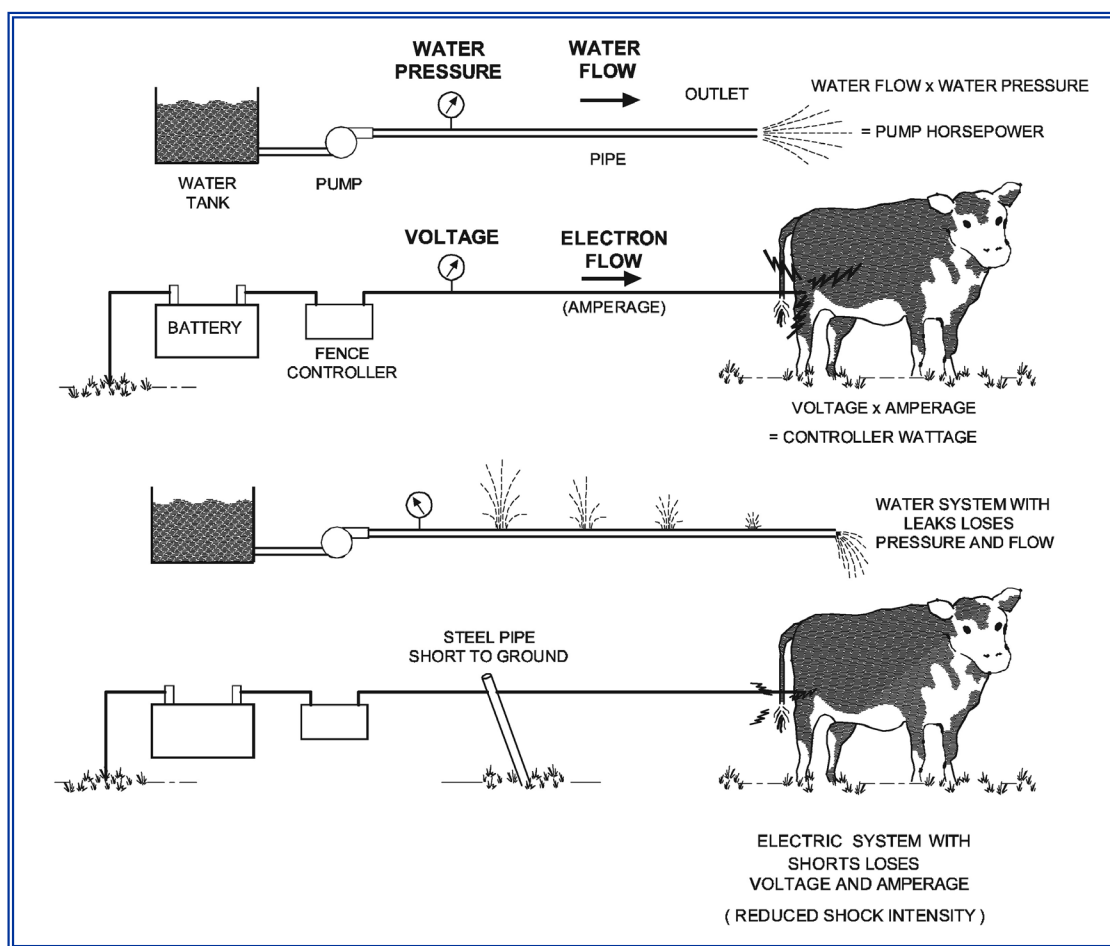


Figure 1 Comparison of Electrical and Water System Terms

Amperage, Voltage, Wattage and Joules

Comparing terms, water flow is similar to electrical amperage and water pressure is similar to electrical voltage. Whereas the rate of water flow times pressure equals pump mechanical power (e.g., horsepower), amperage times voltage equals controller electrical power (wattage). Controllers are commonly energy rated by their wattage per second or *joule* output.

Fence Electrical Circuit

The electrical circuit on a fence is normally “open”; that is, electrical energy is available but is not flowing. The only time we want the circuit to “close” is when an animal touches the fence and completes the circuit (and thereby receives a shock). However, in reality there are sometimes small leakages (short circuits) caused by, for example, grass or other materials touching a wire.

Short Circuits

A short circuit allows some electrical current to flow a “short” return route to ground. Using the water comparison, just as a pipe with holes will have a reduced flow and pressure at the outlet, similarly a wire with short circuits will have a reduced flow and pressure of electrons.

A dead short occurs when all the current is shorted to ground. We know that if water is pumped from a tank into an open-ended pipe, the tank may be soon emptied. So too, if a dead short develops, the controller may “pump” the battery “dry” (or cause a large utility bill). An example of a dead short would be a metal pipe lying on the energized fence wire and touching the ground.

To minimize short circuits, regular inspection of fences is required to locate and remove their sources. To prevent short circuits between the wires and the posts, energized fence wires are insulated with various plastic or ceramic insulators. While uninsulated electric fences may be constructed, the controller will be limited to energizing a very limited length of fence.

Resistance to Current Flow

The resistance to flow is also easy to compare with water systems. A small diameter pipe and/or a long pipe will have a large resistance to flow; so too will a small diameter wire or a long length of fence. The greater the resistance, the greater the pressure (voltage) required to create a flow (current). The shock intensity to an animal from an electric fence is related to the current produced, so high fence resistance to current flow is not desired or beneficial.

MATERIALS FOR ELECTRIC FENCES

The three basic materials for electric fences (posts, wire and controller) have been discussed in other factsheets (posts in Factsheet No. 307.110-1 entitled *Fence Posts – Materials, Installation and Removal* ; wire in Factsheet No. 307.100-1 entitled *Commonly Used Wire for Agricultural Fences* ; and controllers in Factsheet No. 307.310-1 entitled *Electric Fence Controllers*). The many other components in electric fencing can be divided into:

- materials to construct the electric circuit
- materials for lightweight, movable fences

Electric Circuit Materials

Because the fence uses uninsulated wire (livestock must make contact with a “hot” wire), all points of contact between the wire and any point of possible grounding must be insulated. If this is not done, poor shock intensity will result (or only a very short length of fence will be energized).

Some moveable electric fences use insulating posts (fibreglass, polyethylene, etc.) but most fences require an insulator for each “hot” wire on every post. Insulators are also required at tie-off points and other points of possible grounding.

Line Post Insulators

These insulators have the following requirements (refer to Figure 2). They:

- nail or screw onto wooden posts at one or two attachment points
- clamp onto steel posts
- are usually made of plastic (polyethylene or polypropylene) but porcelain is available (more expensive)
- must be able to resist deterioration from the sun (ultraviolet damage is a concern with many plastics)
- must have sufficient separation between the post attachment point and the fence wire to prevent electrical leakage
- must have sufficient surface distance along the insulator between the wire and the post to prevent electrical leakage (between 1 to 1½ inches as measured along the surface)
- must be able to maintain resistance to electrical leakage (wet conditions and dry)
- must have the physical strength to withstand the wire tension loads and the high voltages of fence controllers.

In addition, line insulators should have the following features. They:

- should allow installation of the fence wire after the insulator is attached to the post
- should be reusable
- should not require accurate nailing to prevent damage

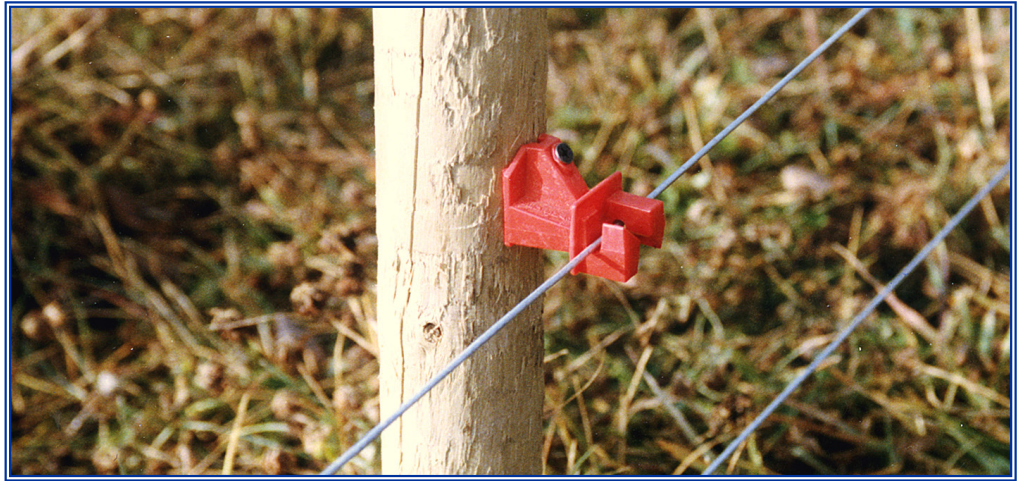


Figure 2 Typical Line Post Insulator

Offset Insulators

Special line post insulators are used to offset an electrified wire from the main fence (i.e., on an old nonelectric fence to extend its life). They will set the “hot” wire up to 6 inches out from the fence to ensure the animals being controlled will contact it before the main fence. These insulators are either all plastic and attached as standard line post insulators, or they are a steel bracket attached directly to the fence wire or post with an insulated eye for the “hot” wire. See Figure 3 below.



Figure 3 Typical Offset Line Post Insulator

Tie-Off Insulators

These insulators have many of the same requirements as line post insulators but require additional strength, as they must resist the entire fence wire tension as shown in Figure 4 below. These insulators:

- are used where fences change direction or at tie-off points
- are made of porcelain or high grade plastic and wire tied to the post
- are made of steel reinforced plastic tubing which the fence wire is threaded through prior to being wrapped around the post (do not use ordinary plastic pipe for this purpose).

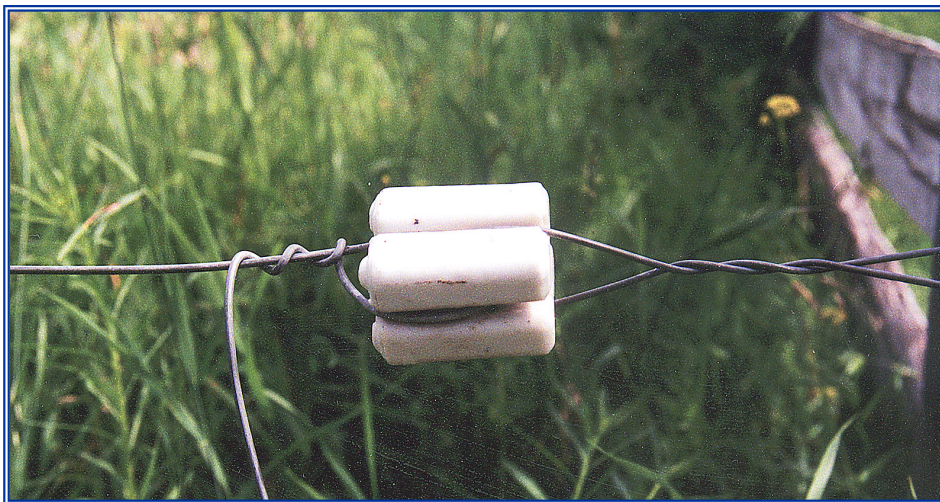


Figure 4 Typical Tie-Off Insulator

Miscellaneous Circuit Materials

There are a number of special items for the construction, testing and maintenance of electric fences:

- various special insulating materials for unique situations
- insulated wire tensioners that can be tied onto posts
- digital volt meters for system checking
- lightning protection devices
- insulating posts with built-in wire attachment points
- indicator lights for distance monitoring of fence circuit
- various cutout switches for isolation of fence sections (refer to Figure 9)
- various devices for permanent or movable connections
- insulated spring handles for simple gates

Movable Fence Materials

One of the main uses of electric fences is for movable, temporary fences. To make frequent fence moving practical, special materials are available as outlined below and illustrated in Figure 5:

- lightweight, insulating posts that can be hand set
- lightweight plastic/steel material in a wire, tape or netting form that is easily dispensed and retrieved
- various reel devices to unwind and rewind the wire
- netting available with insulating posts in a ready-to-use roll
- lightweight dry cell fence controllers

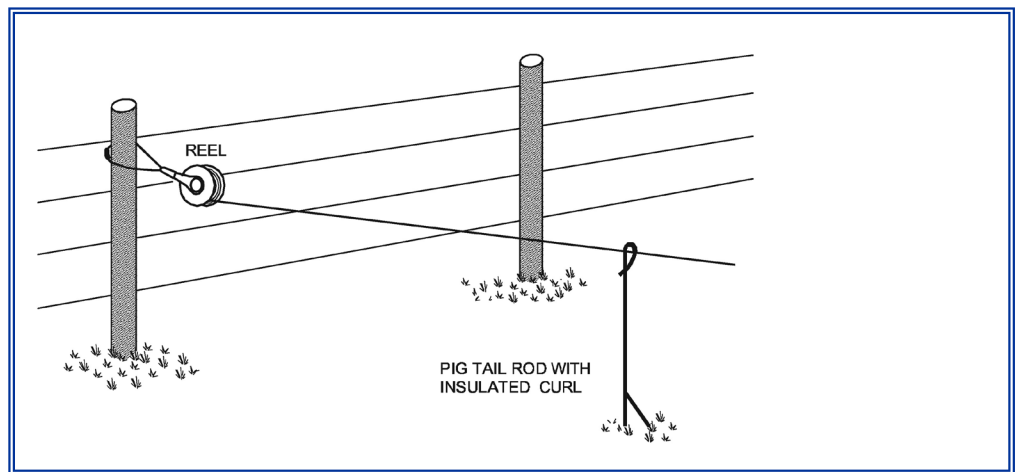


Figure 5 Movable Grazing Control Electric Fence

Gates

The width of gate openings may have to be larger than normal to overcome the animals' tendency to stay back from the electric fence. Refer to Factsheet No. 307.400-1 entitled ***Gates, Cattleguards and Passageways*** for examples of gates for electric fences, and Figure 8 in this factsheet for wiring at a gate.

ELECTRICAL CIRCUIT CONSIDERATIONS

The test of any electric fence is in how well it is wired, i.e., are you getting the most out of the fence controller and is the shock sufficient to control the animals? A single fence, originating at the controller that runs for a short distance, is the simplest and easiest to install successfully. However, many fence installations are far more challenging. The following discussion covers a number of electrical circuit problems.

Wire Joints

There are two basic types of joints in an electric fence as shown in Figure 6, below:

- permanent joints: these must be physically clamped or under some pressure (bolted clamps, crimped sleeves, etc.)
- temporary joints: these are used when the joint is to be "opened" frequently, as in the use of a flexible connector for isolating the bottom wire from growing weeds that will short the fence

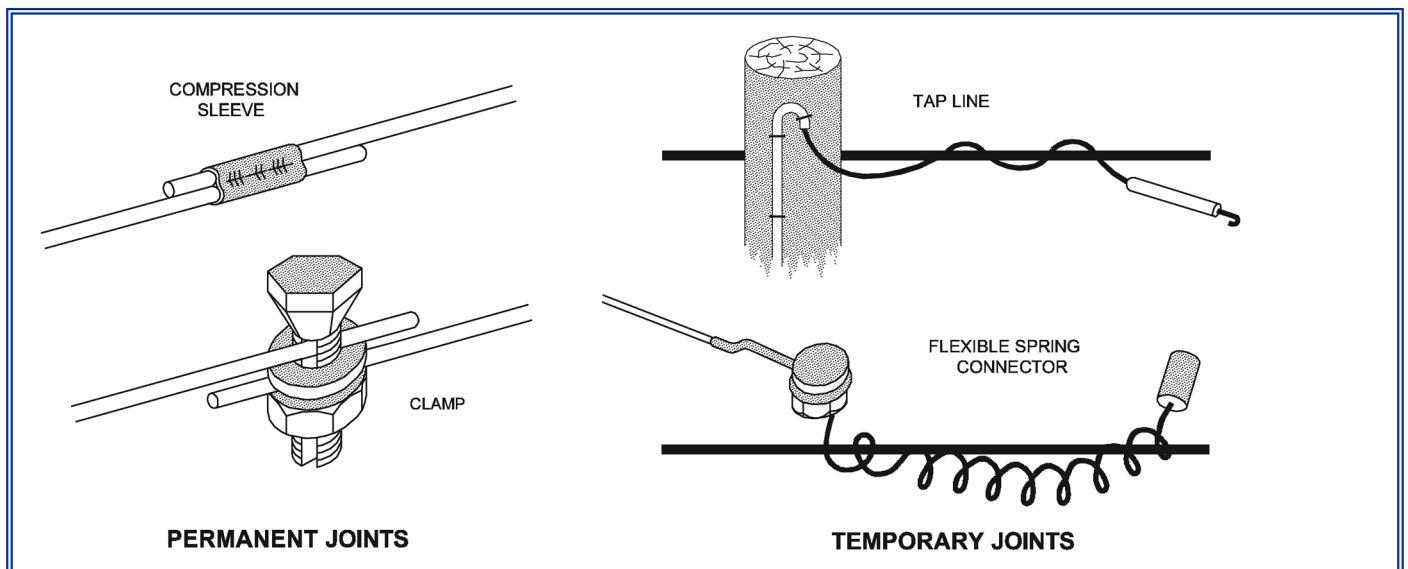


Figure 6 Electric Fence Wire Joints - Permanent or Temporary

Every wire joint is a potential source of electrical resistance and therefore joints must be kept to a minimum. For instance, whenever possible, leave a long wire “tail” at tie-off points to allow the “hot” wires to be easily connected with only **one** clamp.

Referring to Figure 7 below, the left diagram is wrong because twisting wires together makes a poor, high resistance joint and this has far too many joints. The center diagram is also wrong because of the number of joints (also a waste of clamps!). The right diagram is correct - only one joint (clamped) is required when long wire “tails” are left at the post tie offs.

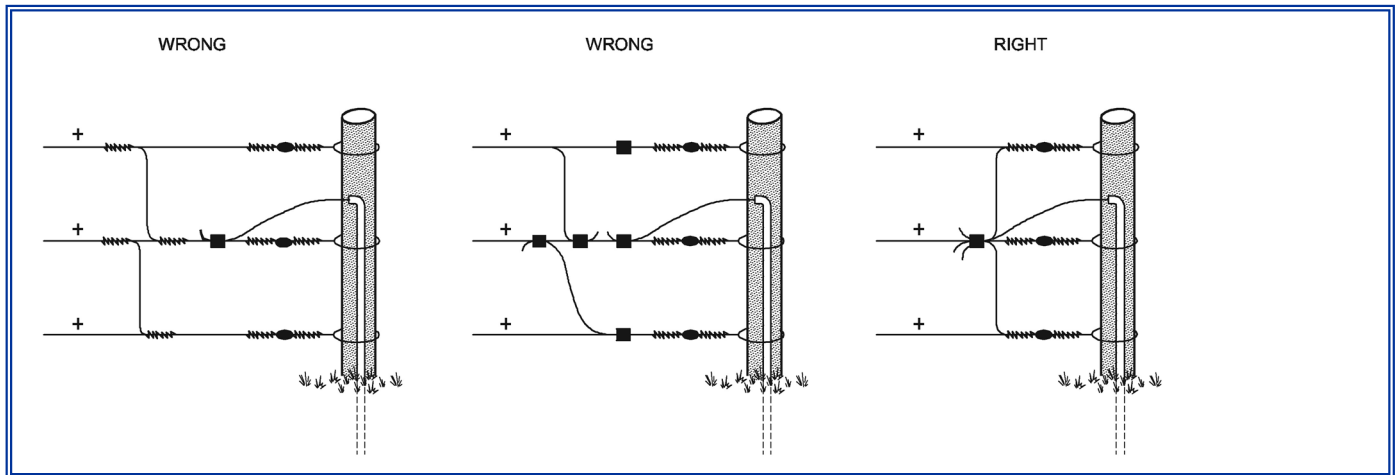


Figure 7 Minimizing the Number of Wire Joints

Joining Wires of Dissimilar Metals

Whenever wires of dissimilar metals are joined in an electric fence, electrolysis can occur. This can result in rapid corrosion and can quickly become a point of high electrical resistance. Different combinations of metals have different rates of electrolysis; for example, a steel/copper joint has a high electrolysis potential. For this reason, these two common wire materials should **not** be used in electric fencing **if** they will be joined together (i.e., do not be tempted to use ordinary house insulated copper wire buried under a gate as it must be connected to the steel fence wire).

Excluding the moisture from a joint will help control electrolysis. However, this is often not effective in fence conditions, even with joint sealing compound; avoidance of dissimilar metal joints is advised. Note that the copper ground wire-to-steel ground rod connection is made using a brass clamp to prevent copper/steel electrolysis.

Leadout Wiring

Often a utility-powered fence controller is chosen even when the utility supply is not close to the fence. A leadout is the supply wire that connects the fence controller to a fence or fences some distance from the utility source. The concern is proper wire sizing to avoid restricting electrical flow that would reduce the shock intensity, and, on long fences, wire “matching” to reduce pulse or surge problems.

Any unwanted current flowing in the leadout must be kept to a minimum. This means any short circuits, faulty insulators or vegetation must be eliminated to ensure the leadout wires are carrying current only as a result of an animal contacting the fence.

The electrical resistance of the leadout wire must not overly restrict the current flow and thereby impair the effectiveness of the shock. Two types of leadouts are common: fence section or single wire leadouts.

Fence Section Leadout. A leadout can be a section of fence of two or more strands from the controller to the main fence being electrified. If the same number and size of wires are on this “leadout fence” as make up the main fence, this will be a good match. This arrangement is also the best when more than one fence radiates out from the leadout. It ensures a low voltage drop both along the leadout and where the main fences start (same number of wires in the leadout & branch fences). The junction point of a number of fences to a leadout can be a location of voltage loss.

Single Wire Leadout. A leadout can be a single wire. If so, it must be sized for low resistance. A number of considerations should be kept in mind:

- as discussed in the water/electricity analogy, a larger diameter wire has less electrical resistance
- choose a wire diameter for low resistance (one gauge larger has 1/3 less resistance; two gauges larger has 1/2 less resistance; and three gauges larger has 2/3 less resistance)

The length of the leadout and the length of the fence being energized are considered in choosing an appropriate wire gauge.

On long fences, a concern arises from the pulse action of the current traveling in the wire. Although the theory is complicated (“surge impedance”), what is important is that a single leadout wire may not be able to properly supply a multi-strand fence if the total leadout and fence are very long (over five km). The general rule is that several standard gauge wires (with the required current resistance) are preferred over one large wire (that may have the equivalent current resistance but would not be able to handle the pulse in the same manner). This is easily achieved by using a leadout fence rather than a single wire.

Reducing Electrical Resistance

As discussed above, electrical resistance can be reduced by using more wires or wire of a larger diameter. Another method to reduce the resistance in an electric fence is to lay it out so that the end of the fence is connected back to itself or some energized portion of the fence. This looping effectively reduces the fence length (note that it may also complicate electrical faultfinding).

Wiring at Gates

Where a gate is required in an electric fence, the circuit must be continued, either:

- **over the gate.** This is often awkward to construct and maintain and may be in the way of large equipment (requires suitably sized posts or post extensions)
- **under the gate.** This is usually the simplest method but requires good insulation and mechanical protection of the wire. Refer to Figure 8.

For an underpass, the electrified wire may be a fence wire threaded into a polyethylene or similar plastic pipe (note that the pipe ends must be bent over to prevent the entry of water). However, this may lead to short circuits which are difficult to repair. A double-insulated wire is a preferable solution (also inside a pipe).

If the grounded wire is to be continued, bury a stainless steel wire or a fence wire in a plastic pipe to reduce wire corrosion. Use a separate pipe from the “hot” wire pipe. In either case, bury the wires at a depth sufficient for protection from vehicle traffic (usually two feet).

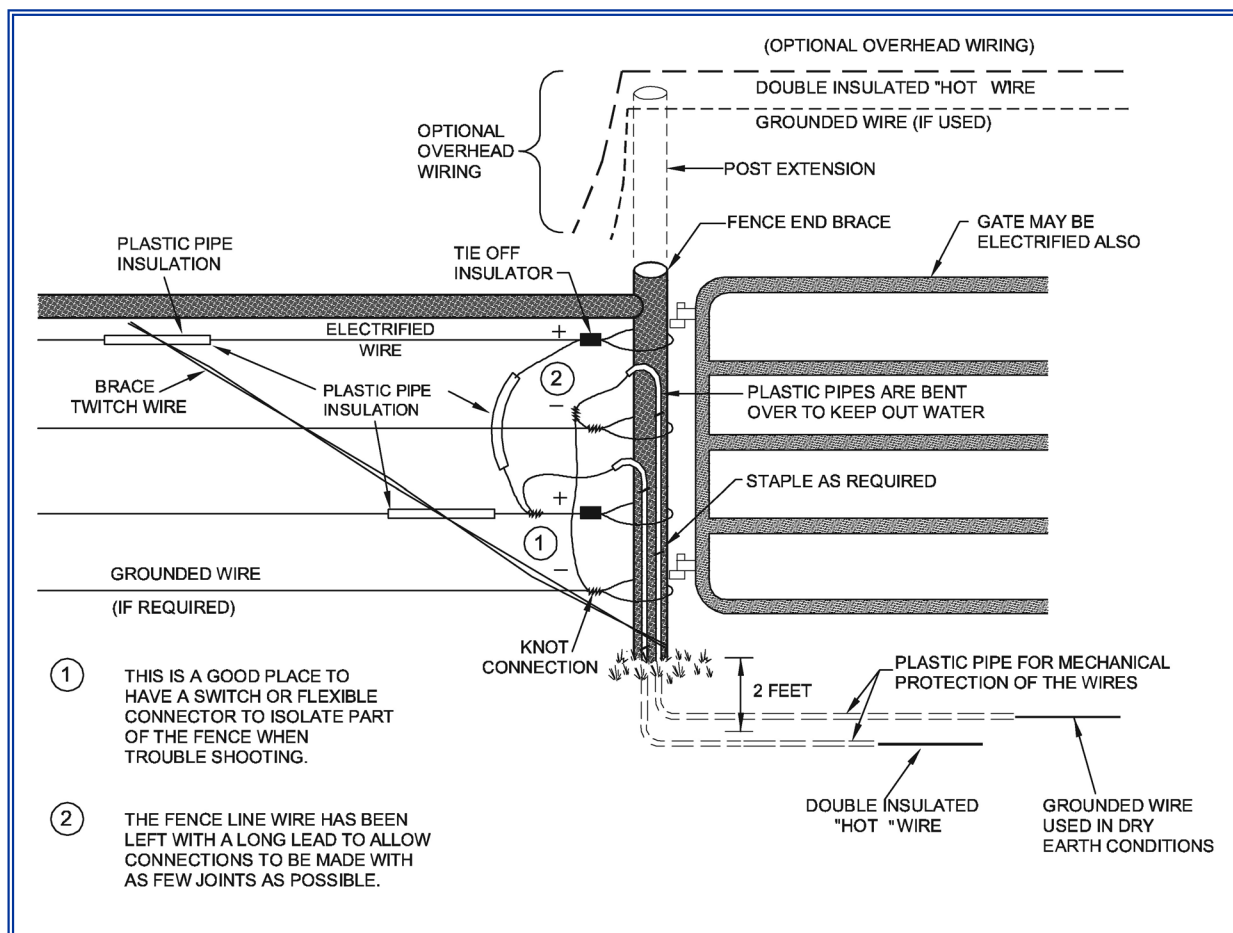


Figure 8 Wiring at a Gate

Cutout Switches

These are installed to switch off parts of the fence to isolate electrical faults or to permit unused fences to be disconnected (ensuring a lower power requirement from the controller). They are especially important for trouble shooting system faults (Refer to Factsheet 307.320-2 entitled *Training, Testing and Trouble Shooting – Living with an Electric Fence*).

A convenient switch location is at a location where a number of fences join or at a gate under or over pass. These switches must be designed for outdoor use or be protected from the weather. Simple plastic fence switches are available as shown in Figure 9. See also the temporary wire joint discussions on previous pages.

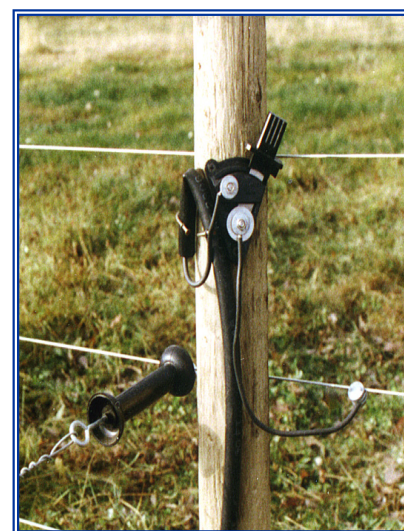


Figure 9 Typical Cutout Switch

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ELECTRIC FENCE CONTROLLERS

An electric fence is a psychological barrier that uses a short duration electric shock to control livestock. This shock is supplied by the fence controller, which transforms a standard electrical energy source and energizes the fence wires.

Electric Fence Controllers

The electron “pump” for an electric fence is the fence controller, commonly called an energizer or charger. This device is the heart of the system and is available in three forms:

- A controller that uses utility power - 115 or 230 volt (used when close to the utility),
- A controller that uses a rechargeable wet cell battery (typically 12 volt; used when remote from the utility and for portability),
- A controller that uses a replaceable dry cell battery (typically 6, 9, or 12 volt; used for remote sites and for easy portability).

The controller must be able to do two things to be effective:

- Overcome the insulation resistance of the animal hair and hide, and then,
- Deliver a shock of sufficient intensity to be effective.

Shock Delivery

First of all, a controller must produce enough voltage (electrical pressure) to overcome the resistance of the hair and hide of the animal. This is termed the guard voltage and is given by the type of livestock; minimum values are:

- 700 volts for short-haired animals (such as cows)
- 2000 volts for long-haired animals (such as sheep)
- 2500 volts or greater for other animals (such as deer).

If a controller maintains a guard voltage above the minimum, the animal will receive a shock. If not, no shock will be felt. The guard voltage only means a controller has the voltage to deliver a shock but is not a measure of the shock intensity.

Shock Intensity or Effectiveness

A controller with sufficient guard voltage will deliver a shock, but what is the intensity or effectiveness of the shock? It depends on the fence, the reaction of the animal and other operating conditions, all of which are difficult to measure. However, indicators of shock intensity are the peak current and electrical energy outputs delivered by the controller under field conditions.

The peak current is the maximum current delivered during the shock measured in amperes (amps). It is not related to the duration of the shock. High currents indicate high shock intensities.

The energy output in a shock is the combination of amps, volts and the shock time and is measured in *joules*. High energy values indicate high shock intensities. Electric fence controllers are often rated by joule output. Shock time is related to the pulse of the controller.

Controller Pulse Output

Modern controllers are sophisticated electronic devices that are capable of energizing many miles of fence. The electric current flow sent out from the controller to the fence wire(s) is in the form of a pulse that is only “on” for a brief time. The pulse “on” time is typically about 0.3 milliseconds (3/10,000 of a second) and occurs about one pulse a second. This is for safety reasons so animals or humans can free themselves from the electrified wire(s) during the “off” time. This pulsing is automatically controlled and in some cases is adjustable, either faster (for training livestock) or slower (to conserve energy; most useful on battery controllers).

Because of this pulsing action, the dynamics of the electricity flowing in the fence wire(s) is quite complicated. It could be compared to wave action from a rock thrown into a pond. Pulses can reflect back from the end of a fence and often make troubleshooting a challenge, especially on fences over five km or ones with long leadout wires.

Pulse behavior is designed by manufacturers in the fence controller circuitry. This is a feature that may distinguish one controller from another.

115/230 Volt Controllers

These controllers are plugged into the utility electrical service and are most often used at the farm or ranch home site. They:

- are CSA tested and approved
- are amongst the most powerful
- are often the least cost per energy (joule) output
- are the least expensive to operate
- are not portable.

Battery Controllers

These controllers require a battery for energy supply and are used for sites remote from a utility electrical supply. They:

- are not tested or rated by any agency
- are usually in the low to middle power range
- are powered by dry or wet cell batteries of various voltages
- are portable
- may use a solar panel to trickle charge a rechargeable battery.

Wet Cell Batteries for Controllers

Because the fence controller “load” is always on and will discharge a battery, regular automotive type batteries are not usually selected. These engine starting batteries are only meant to be discharged about 10% (a 10% depth-of-discharge) on a regular basis or they will not recharge properly. A deep discharge battery, however, can be taken to 50 to 80% depth-of-discharge and are best for electric fence controllers.

Solar Panels for Battery Controllers

Fence controllers that are powered by a rechargeable battery may have a solar or photovoltaic panel added to maintain the battery charge. When the sun shines on a photovoltaic panel current flows to the battery. They are therefore most effective in the high sunshine period of the year but can be sized for any condition. This panel only “trickle charges” the battery and does not directly energize the fence.

Controllers are available with built-in panels. However, the panel should be sized for the local solar conditions and the built-in panel may not be adequate to maintain the battery charge. Note that poorly insulated fences or ones with a lot of vegetation on the wires may have a larger than expected loss and drain the battery even with a solar panel.

One manufacturer uses a built-in microprocessor to control the output of a battery/solar panel controller. On cloudy days or when the battery is low the pulse rate is reduced to conserve energy.

Some solar panels are advertised as "self regulating". These are not actually different from any others except they are sized so their voltage output matches the battery voltage, to avoid battery overcharging.

Uni-polar and Bi-polar Controllers

Fence controllers can be categorized by the number of energized terminals (or poles) that are connected to fence wires. Most commonly used fence controllers are uni-polar; that is they have one energized terminal (positive) and a negative or ground terminal. Fence wires are either all positive, or alternatively positive and grounded. Only the positive wires are insulated at fence posts. The full controller voltage is available between either the positive and grounded wires or the positive wire and ground.

Bi-polar have two energized terminals (a positive and a negative) that are connected to fence wires, plus a ground terminal. With this arrangement, full voltage is available between a positive and a negative wire with **one-half** the full voltage between either wire and ground. This feature in a controller allows a fence to have all wires energized with only one-half the losses occurring from wires that become short circuited by grass, etc. In poor conditions, this type of controller may be more effective than a uni-polar style.

Purchasing a Controller

The following are some general things to consider in addition to those already discussed previously:

- Choose a utility powered controller for a permanent fence
- Remember a manufacturers' rating in “¼ miles” is for miles of wire not miles of fence (i.e., a controller rated for 6 miles is sufficient for 1.5 miles of four electrified strands of fence)
- A wet fence environment will require more controller power than a dry one (more potential short circuits).

Safety Considerations

Electricity must be respected at all times. To ensure the safe installation of an electric fence controller:

- Use only CSA approved plug-in type controllers.
- For plug-in type controllers, ensure the supply electrical service has been inspected by an electrical inspector.
- Use battery controllers from reputable companies (note that there are no provincial regulations regarding these controllers).
- Install the controller according to the manufacturers' recommendations
- No more than one controller may electrify a fence at any one time.

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Fencing FACTSHEET



Ministry of
Agriculture

Order No. 307.320-1
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GROUNDING SYSTEMS FOR ELECTRIC FENCES

The majority of electric fence problems relate to grounding concerns. This factsheet looks at the two methods of system grounding commonly used and how to test a grounding system.

THE EFFECT OF SOIL CONDITIONS

Electric fences are designed so the animal will complete the electrical circuit upon touching the fence wire. This forms the closed circuit required for electrons to flow. For simplicity, the standard electric fence uses the earth as the “return” leg of the circuit. This is only effective if the conductivity is good, as in moist soil.

If the soil is dry, frozen or snow covered the conductivity is reduced which reduces the effectiveness of the electric fence. For areas that

receive 24 inches or less annual precipitation (or where the precipitation is poorly distributed throughout the year), a “wire return” system should be used.

GROUNDING IN MOIST EARTH CONDITIONS (Earth Return)

This is the standard grounding situation as shown in Figure 1. The moisture in the earth is sufficient to allow a flow of electrical current that will ensure a shock occurs. The critical component is the soil

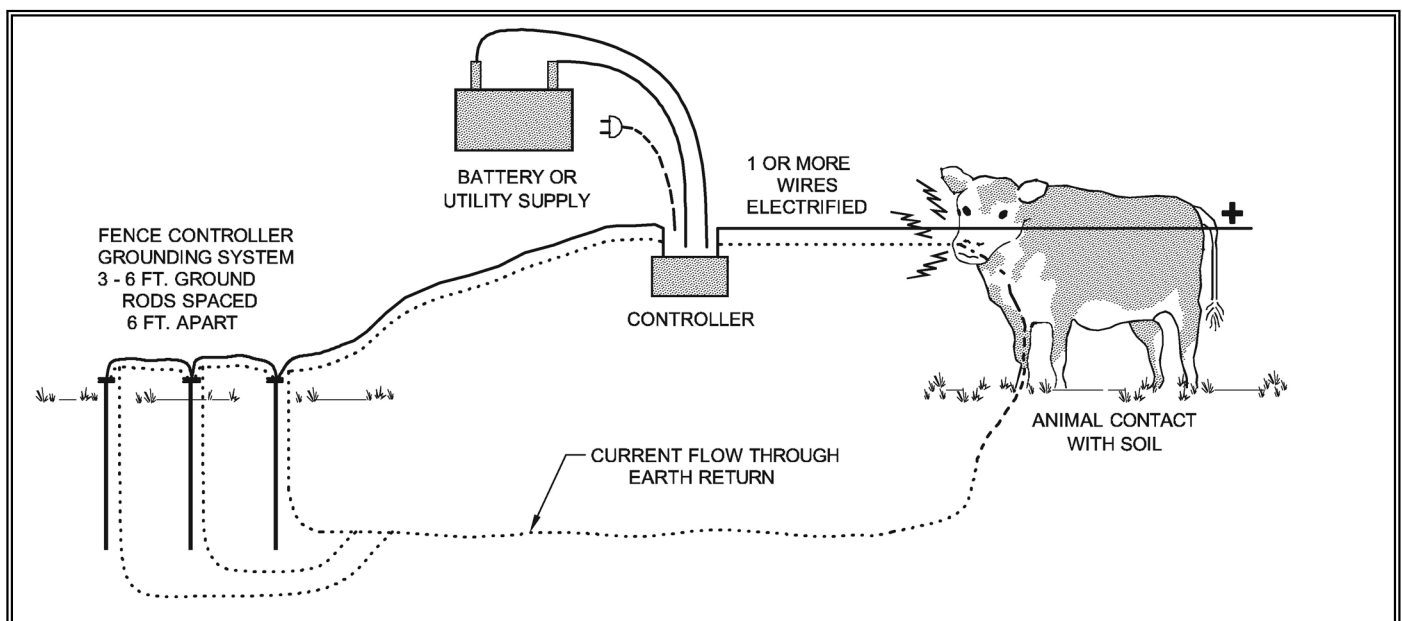


Figure 1

Grounding in Moist Earth (earth return)

contact of the grounding rods. They connect the earth return current flow to the controller and must have good soil contact to ensure this flow is not restricted. This requires:

- For safety reasons, a location for the grounding system that is at least 7 feet from any other electrical or telephone grounding system and from any building foundation (especially a dairy barn) or underground water piping
- A location where the wiring cannot be easily damaged or disconnected by livestock or machinery (see below regarding burial)
- A minimum of 3 galvanized steel earthing rods, driven into moist earth; (these need not be located right at the fence controller but must be at a moist earth location)
- A separation space between the rods of 6 feet
- A continuous length of wire for connection between the rods and the controller
- A standard electrical grounding clamp (noncorrosive) for each rod/wire connection.

A grounding system that will meet the Electrical Code for grounding uses the following standard electrical components:

- Galvanized steel ground rods, 6 feet x 5/8 inch diameter,

- Brass or copper clamps, and
- #6 bare copper wire from rods to controller.

Although a smaller wire size may be adequate, a #6 wire may be directly buried which is a good method to protect the system from damage. The grounding rods can be driven 6 or 8 inches below the earth surface, say into a small dug depression. The wire can be laid into a shallow trench, clamped to the rods, then buried. The wire may be buried all the way to the fence controller.

Note that where this controller ground is near a building with an electrical service, the wire from the ground rods to the controller should be insulated to avoid 'cross grounding'.

In addition to this main grounding of the fence controller, secondary grounding of the nonelectrified fence wire(s) may be done as explained for the "wire return" systems.

GROUNDING IN DRY EARTH CONDITIONS (Wire Return)

In dry, frozen or snow covered conditions the earth return system is not sufficient to ensure current flow that will produce a shock. In these conditions, one or more fence wires are used for the return circuit to the fence controller (in addition to the earth grounding of the fence controller) as shown in Figure 2.

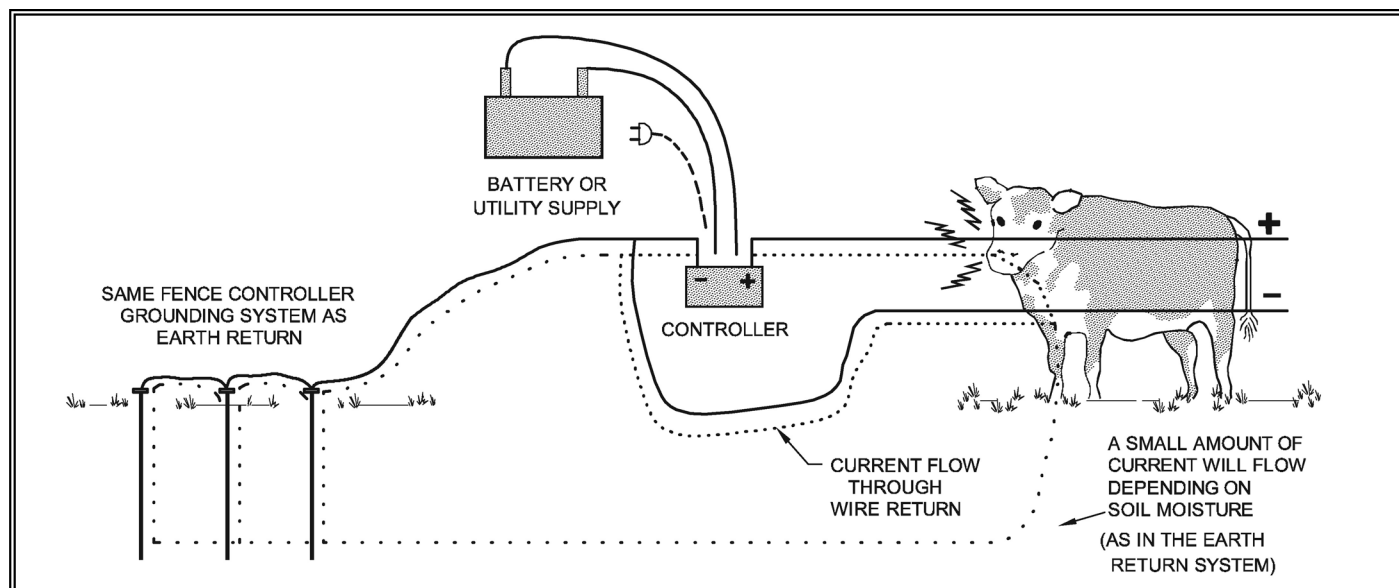


Figure 2

Grounding in Dry Earth (wire return)

This method ensures a circuit when the animal touches both an energized wire and a grounded wire (in semi-wet conditions, some current may also flow via the earth return). A shock then occurs even in these poor earth return conditions (i.e. dry, frozen or snow covered).

The nonelectrified fence wire(s) are connected to the main fence controller grounding system **as well as** to single groundrods located approximately every 1/2 mile along the fence line (more frequently in very dry conditions). These ground rods are the same as the main grounding rods. To ensure the animal can easily contact a “hot” wire and a grounded wire and thereby receive a shock, alternating fence wires may be electrified and grounded. However, while being more effective, it may cause maintenance problems as any debris that may contact the fence wires will more easily short out the circuit than if contacting a “hot” wire and the earth.

SALT CORE GROUND RODS

For very dry sites the main ground rods may have high resistance to current flow. This can be greatly reduced by using the following technique (which adds salt around the ground rods to increase the soil conductivity and a clay material to hold moisture):

Auger or dig 3 holes for the ground rods that are at least 3 inches diameter by 4 feet deep, spaced 35 feet apart

- Fill each hole with a wet slurry of 2 parts Bentonite (a clay material sometimes called “driller’s mud”) and 1 part coarse salt
- Place a 4 foot by ½ or ¾ inch diameter stainless steel tube down the center of the hole (stainless because of the corrosive nature of salt)
- Cover the area with an inch or two of sand to reduce evaporation.

The ground wire is clamped to these tubes as before. To ensure continued low resistance, these salt core ground rods can be watered during drought conditions.

TESTING THE GROUND SYSTEM

The earth return system of grounding a fence controller relies on the soil moisture conditions for current flow and these conditions change throughout the year. To ensure continued fence performance, a yearly grounding check should be made, preferably at the driest season the fence is being used. The following procedure should be followed (see Figure 3):

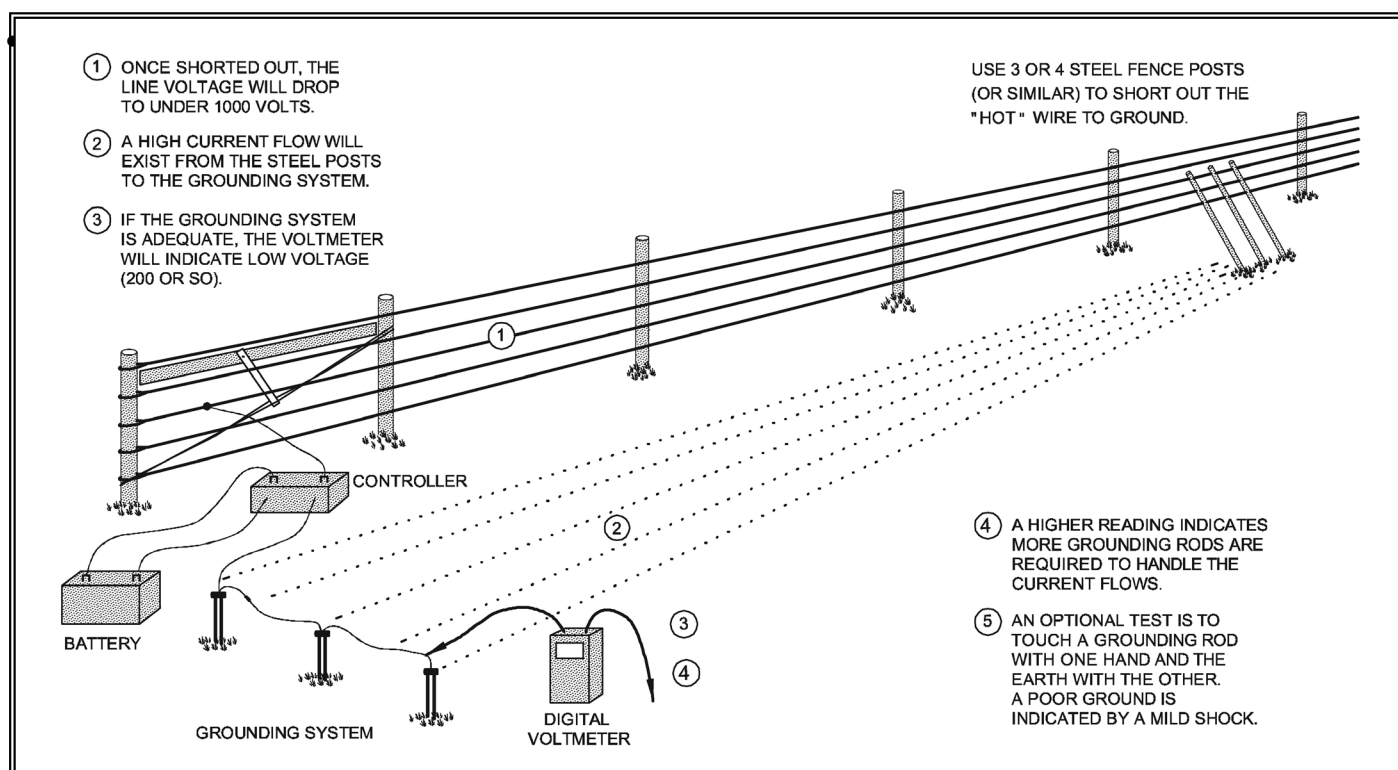


Figure 3

Testing a Fence Grounding System

- About 300 feet from the controller connection to the fence, use 3 or 4 steel fence posts (or similar steel material) to create a dead short from an energized wire to the earth
- This will reduce the fence line voltage to less than 1000 volts and put the grounding system under load with a high flow of electrons trying to get through the soil back to the energizer
- Using a volt meter (suitable for electric fences), measure the voltage between the ground wire to the controller and the earth at least 3 feet from any ground rod
- If the grounding system is adequate the flow will all be handled by the ground rods and the meter reading will be very low (200 volts or so)
- A higher meter reading will indicate the grounding system cannot handle the flow and more ground rods are required
- Add another ground rod and repeat the test.

(An optional method is to skip the meter and simply grasp a ground rod with one hand and touch the earth with the other hand. A poor ground is indicated with a shock, the severity of which will depend upon the condition of the grounding system. This is not recommended except for the foolhardy.)

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Fencing FACTSHEET



Order No. 307.320-2
Revised December 2015

TRAINING, TESTING AND TROUBLE SHOOTING

Living with an Electric Fence

This Factsheet discusses using and maintaining an electric fence. Refer to the other fencing Factsheets for detailed electric fence information, such as elk exclusion and livestock control.

TRAINING LIVESTOCK

Unless an animal has had some exposure to electrified wires, they cannot be expected to respect or be controlled by them. Training requires livestock to be able to receive a shock to discover the result in touching a "hot" wire.

This should be done in a low stress, securely fenced area such as electrified offset wire on a well fenced field. Ensure full voltage on the offset wire before livestock are exposed to it for best training results.

If the controller has a fast or training speed, select it for this purpose. To attract attention and encourage touching the wire, tie tape or shiny tin foil on the wire.

Regular contact with electric fences is also important to reinforce the training experience. In other words, the more electric fencing livestock are exposed to the better it will work.

TESTING THE GROUND SYSTEM

The earth return system of grounding a fence controller relies on the soil moisture conditions for current flow and these conditions change throughout the year. To ensure continued fence performance, a yearly grounding check should be made, preferably at the driest season the fence is being used.

The following procedure should be followed (see Figure 1):

About 300 feet from the energizer connection to the fence, use 3 or 4 steel fence posts (or similar steel material) to create a dead short from an energized wire to the earth.

This will reduce the fence line voltage to less than 1000 volts and put the grounding system under load with a high flow of electrons trying to get through the soil back to the energizer.

Using a volt meter (suitable for electric fences), measure the voltage between the ground wire to the energizer and the earth at least 3 feet from any ground rod.

If the grounding system is adequate the flow will all be handled by the ground rods and the meter reading will be very low (200 volts or so).

A higher meter reading will indicate the grounding system cannot handle the flow and more ground rods are required.

Add another ground rod and repeat the test.

(An optional method is to skip the meter and simply grasp a ground rod with one hand and touch the earth with the other hand. A poor ground is indicated with a shock, the severity of which will depend upon the condition of the grounding system. This is not recommended except for the foolhardy.)

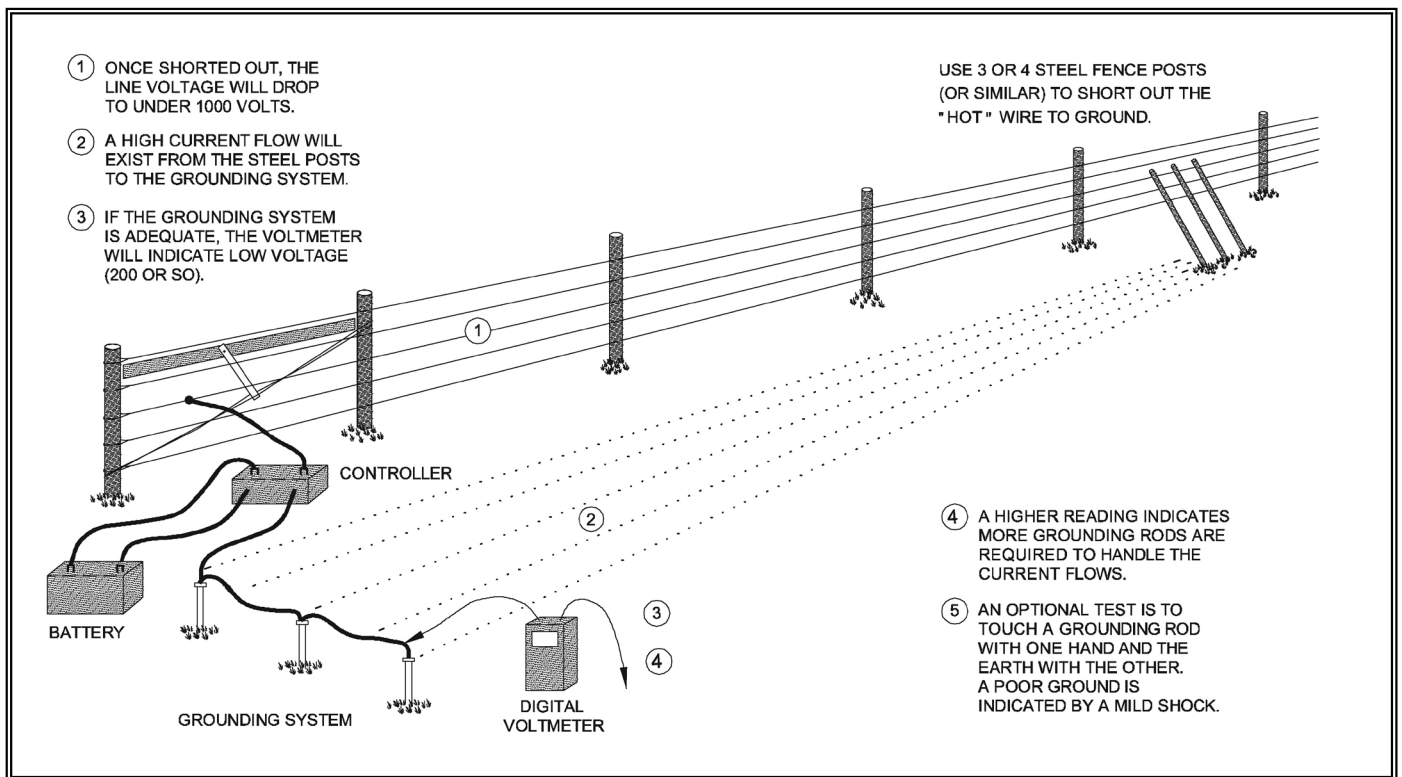


Figure 1

Testing a Fence Grounding System

TESTING FOR EFFECTIVE VOLTAGE

The delivery of an effective shock depends upon the proper voltage (or pressure) being present in the fence wire(s). This voltage can be:

Indicated by the use of a 2 or 3 bulb light tester (typically will only indicate low, medium or high voltage ranges).

Measured by the use of a voltmeter (which must be made especially for the pulsing, high voltage in electric fences).

Small, digital voltmeters for electric fencing are available which read peak voltage levels in kilovolts (i.e. a wire with 4500 volts would have a meter reading of 4.5). They are indispensable in testing and fault finding. Voltmeters are preferred as they give an actual voltage reading not merely a level range as do the light testers (see Figure 2).

To read the voltage on a wire, clip one of the voltmeter leads to the "hot" wire and touch the other lead to earth

or a grounded wire. The meter will indicate the voltage (or pressure) between the two points. This is the simple way to use a voltmeter to locate faults (see "Trouble Shooting - First Step" below).



Figure 2

Typical Electric Fence Digital Voltmeter

However, this reading only indicates the “steady state” condition and not voltage losses due to high resistance. A high current flow in the wire will more accurately assess resistance or faults (similarly, reading of the water pressure in a static pipeline does not indicate friction losses unless water is flowing). To find the actual conditions that are present when an animal touches a wire, use the method below, “Trouble Shooting High Resistance”.

TROUBLE SHOOTING

– The Beginning

First of all, check to ensure:

- The fence controller output is correct (disconnect the fence and measure the voltage across the controller terminals).
- The grounding system is adequate (see Testing the Ground System).

If these two components are fully functional, then any faults are on the fence somewhere. **Trouble shooting methods are simply a process of elimination.**



Figure 3

Typical Cutout Switch

For anything but the simplest of fences, trouble shooting is made easy if the fence layout allows for isolation or circuit removable of portions of the fence. This is when the use and placement of cutout switches (see Figure 3) or temporary joints becomes important.

TROUBLE SHOOTING

– What To Look For

Fence line faults that will cause a loss of voltage are either:

- Faults that cause a short circuit - these provide a return circuit that does not allow the remainder of the fence to be energized, such as crossed wires, broken insulators and vegetation on the wire, or
- Faults that cause a high resistance to current flow - these reduce the voltage available to the remainder of the fence, such as poor or corroded connections.

TROUBLE SHOOTING SHORT CIRCUITS

For these common electrical faults:

- Using the cutout switches, and taking voltage readings along one section of fence at a time, faults will be indicated as a sudden drop in voltage (a drop greater than the normal drop along the same length of wire).
- Go back along the fence until the voltage rises again and the fault will be between those two points.
- If no faults are located in the first section of fence, switch on the next section and continue taking voltage readings until a voltage drop is located.
- If the voltage gradually drops along the fence line you may be approaching a dead short.

Another way of locating these types of faults is with the use of a portable radio. Tune the radio off station and walk along the fence noting the sound and volume of the “static”. This will change as a fault is passed as the fence short circuit will create an arcing sound that is picked up on the radio.

TROUBLE SHOOTING HIGH RESISTANCE

The following test will give an accurate indication of the voltages on the fence **when an animal touches the wire**. It will not be required for the routine type of faults such as short circuits.

If after checking for short circuits the fence shock still does not appear adequate or is not controlling the livestock, it may be high resistance points along the wire(s). These can be located by:

- Using a steel stake or similar material, short the “hot” wire to earth or to the grounded wire to create a flow of current (the steel stake is placed at the far end of the fence from the controller, past where the voltage is to be measured).
- Measuring the voltages along the fence, a sudden voltage drop will indicate points of high resistance (i.e. either side of a wire joint).

Note: this “complete grounding” method produces a higher current flow than would occur with an animal touching a wire so the voltages are not quite as in an “operating” situation; for actual indications of the voltages experienced by the animal, use a 500 ohm resistor instead of the steel stake.

An example of using this method would be:

- If high voltage is measured on the wire but falls when it is shorted out; wire insulation would be adequate (there was high voltage under no load) but there must be points of high resistance along the wire (as there is low voltage with current flow).

Note: if low voltage is measured initially, first check for short circuits such as vegetation on the wires or crossed wires.

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GATES, CATTLE GUARDS AND PASSAGEWAYS

This factsheet looks at various options for allowing passage through fences for livestock, wildlife and people.

GENERAL REQUIREMENTS

A dictionary definition of a gate is “an opening into an enclosure”. A gate is required to allow movement across a fence line that has been erected to stop such movement. A gate may regulate movement of:

- machinery and livestock using, e.g., hinged sections of fence
- machinery only using, e.g., cattle guards
- livestock only, using, e.g., corral handling, sorting and separation of livestock
- people only, using, e.g., various stiles or passageways
- water only, using, e.g., various floodgate designs
- wildlife, using, e.g., single direction gates

An effective gate must allow passage while having the following features:

- convenience and appropriate location
- wide enough (to allow passage of equipment)
- high enough (usually as high as the fence)
- if hinged, free from obstacles to open fully
- if latched, convenient yet stock proofed to prevent accidental opening
- durable
- cost effective

Generally, the more often a gate is used the better quality it should be. Gates may be constructed of metal, wire, wood or combinations of these materials. They may be electrified in the case of electric fences. They may be hinged or ‘slip-wired’, hand latched or automatically latched. They may have adjustable mounting for deep snow locations. These and other options are covered in the following discussions.

Locating Gates

Roads, pathways, streams or other reasons may determine gate location with little choice available. In these cases, choose a suitable design from the following layouts. However, if the gate location is not certain, consider the following:

Livestock generally will move easier through a gate located at or near a fence corner rather than one placed along the fence.

The movement of machinery will require a safe distance of straight road on either side of the gate. If a turn is required, the gate may have to be made wider than standard.

Gates on boundary fencelines on busy roads should be set back from the fence line a distance sufficient to allow vehicles a safe pull off distance prior to reaching the gate, as in Figure 1 below. This distance should accommodate the longest truck or tractor/implement combination on the farm.

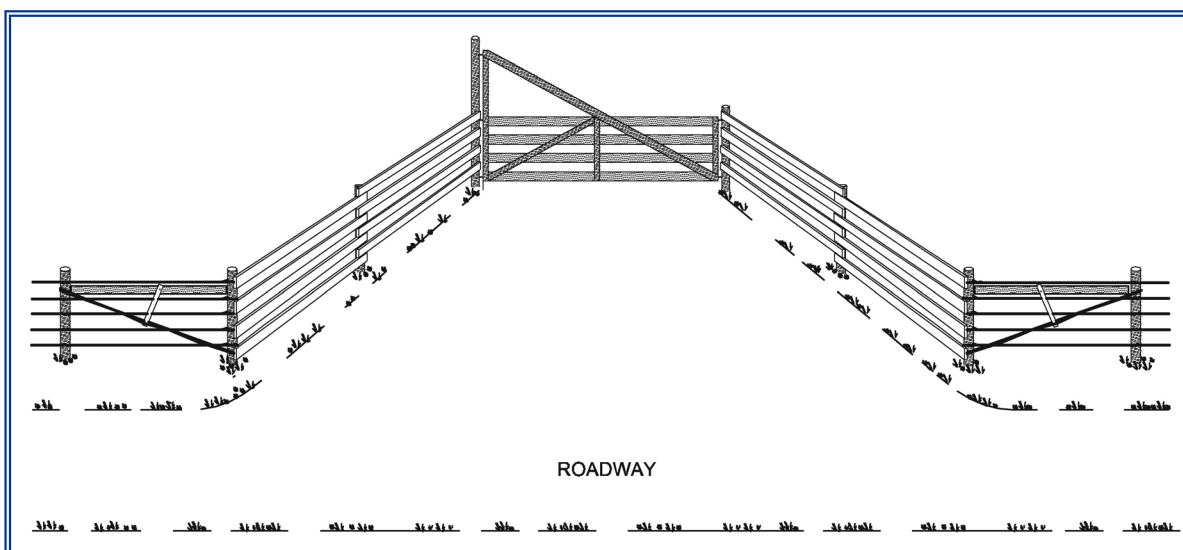


Figure 1

Gate Set Back From a Roadway

Gate Hinges

Gate hinges can be custom made or purchased. The bottom of the gate hinge post may simply be pinned into a base of wood, rock or concrete with the upper end boxed into the fence post or the gate may be hung on a suitable fence end post with steel hinges. Hinge choice depends to a large extent on the weight of the gate. All-wood gates are more difficult to support than lighter steel, wire or aluminum gates. See Figure 5 for estimated weights of typical wood gates.

If a gate is to swing 180° back onto the fence, the hinge must be located offset to that side of the hinge post as shown in Figure 2 below. The gate, however, will not open as wide in the reverse direction.

As well as hinge design, the fence post will be affected by the weight of the gate. If standard fence-end posts are used, gate weight must be limited. A larger post set deeper with additional bracing will be required for heavy gates. Standard fence brace end posts should be supported by using a second brace wire as discussed in Factsheet No. 307.220-1 entitled ***Brace Assemblies for Wire Fences – What They Are, How They Work, How to Construct Them.*** Over-length end posts can be supported using a cross support or a diagonal pole down to a fenceline post. Some gate mounting and hinge options are shown in Figure 3.

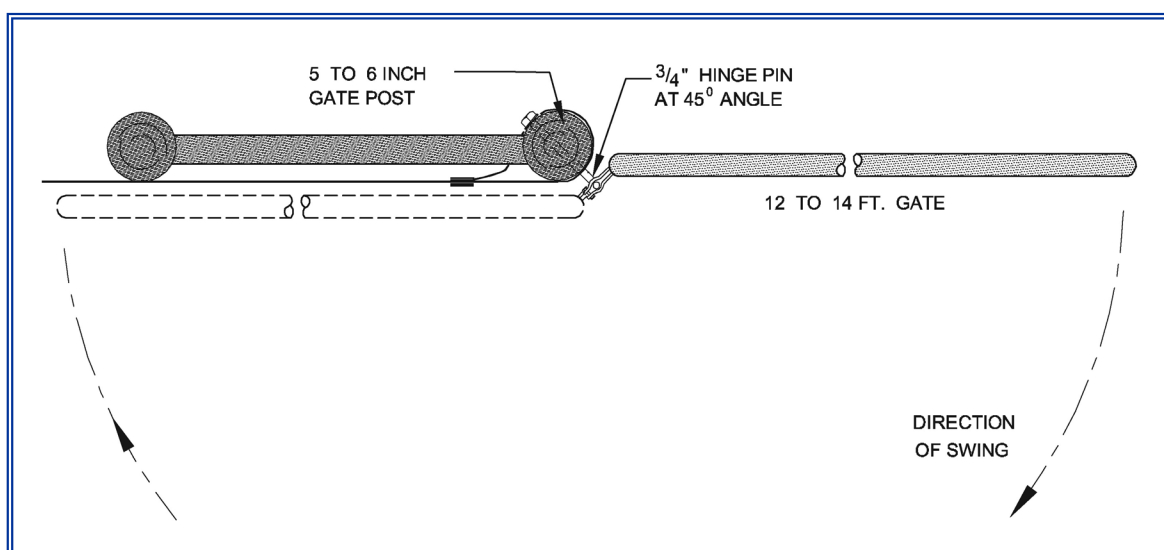


Figure 2

Offset Hinge (full one-way swing)

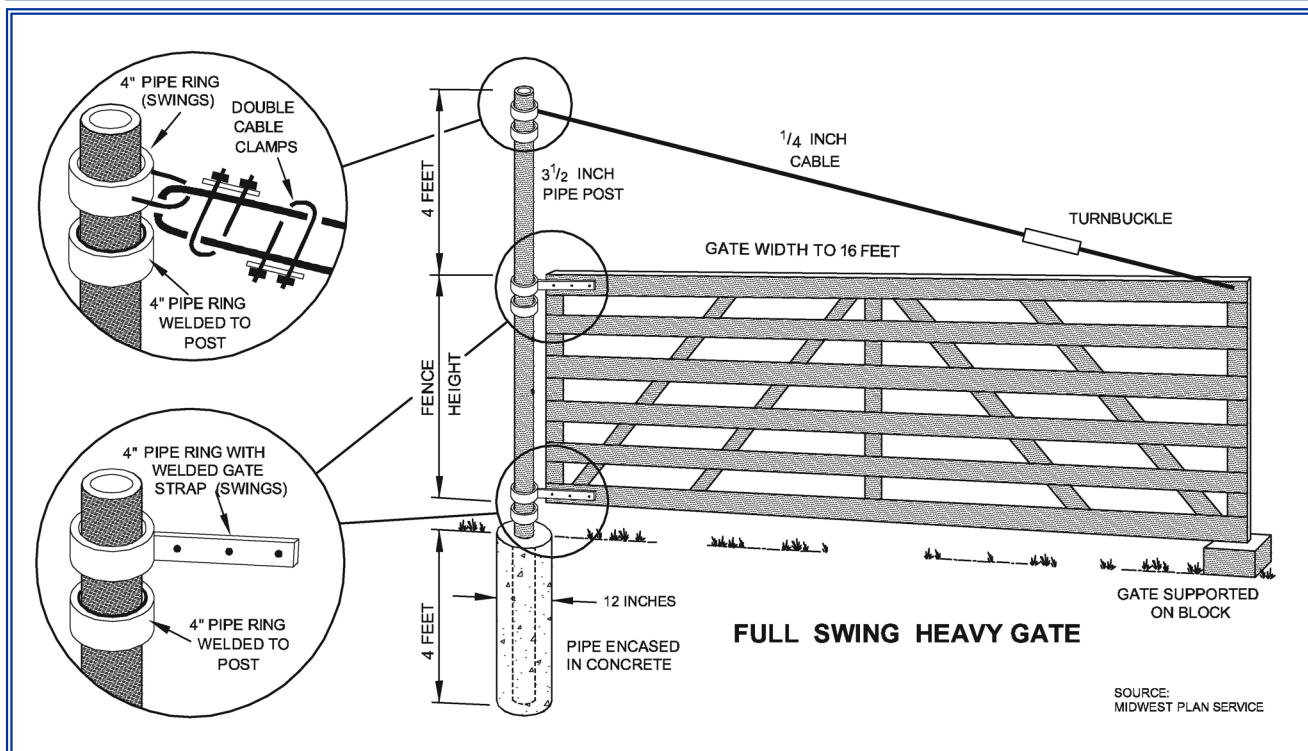
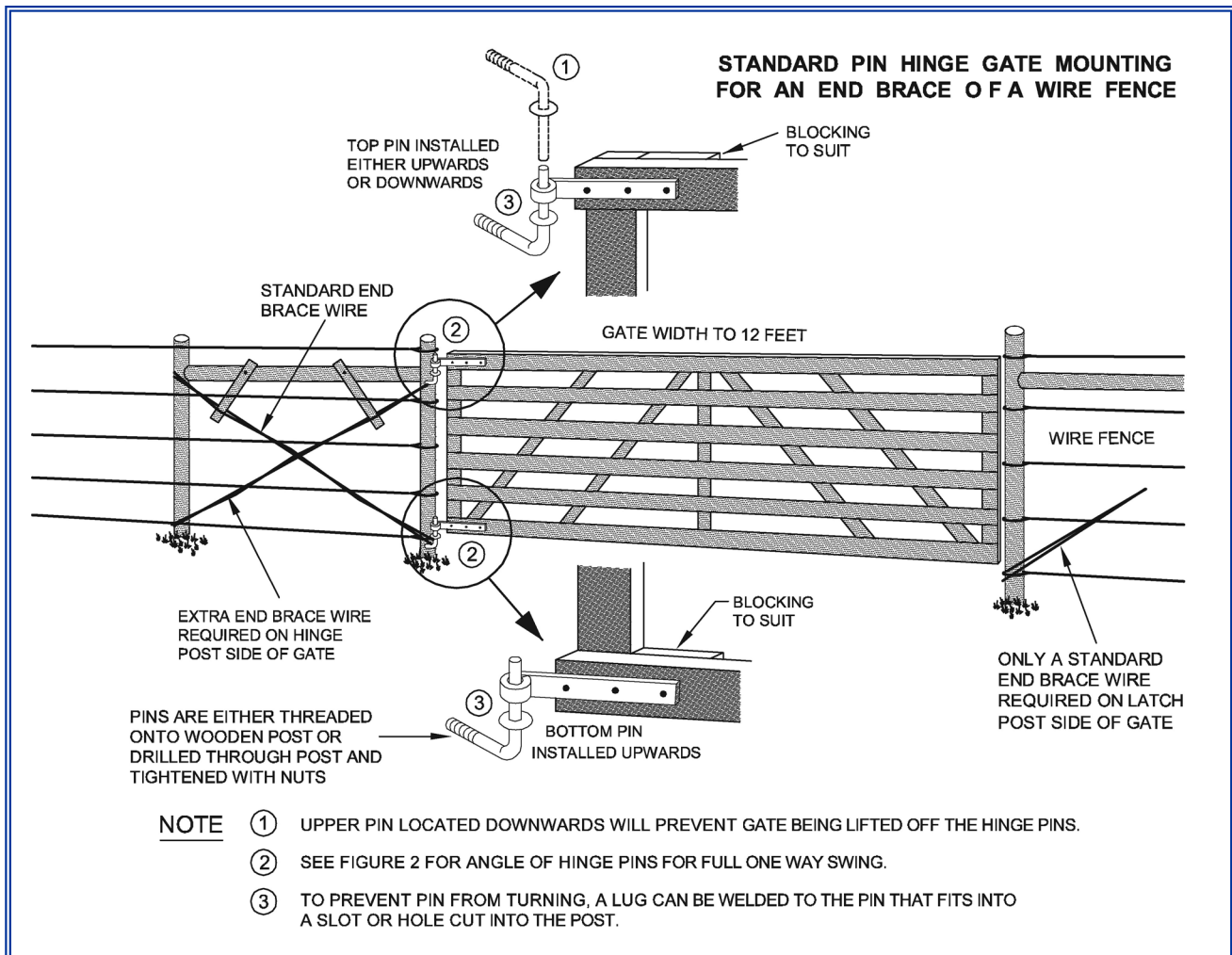


Figure 3

Gate Mounting and Hinge Options

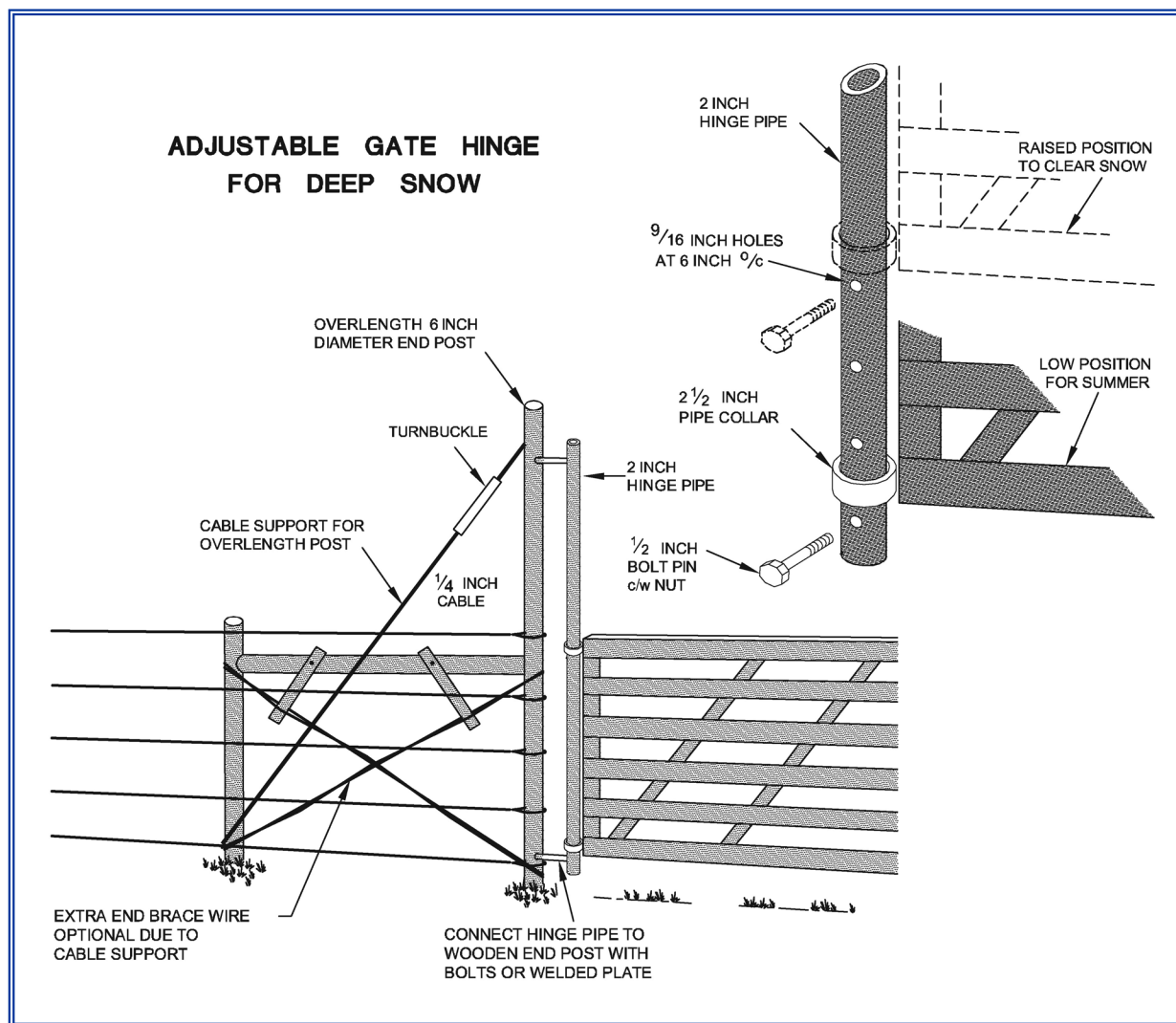


Figure 3 (continued)

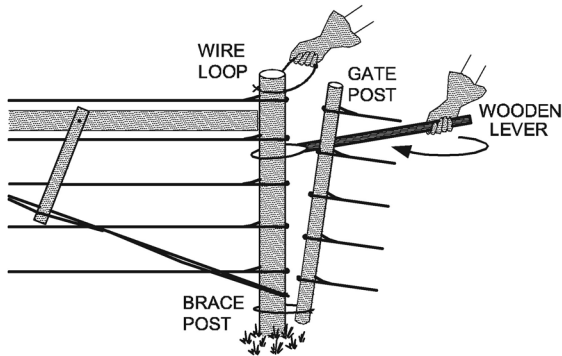
Gate Mounting and Hinge Options

Gate Latches

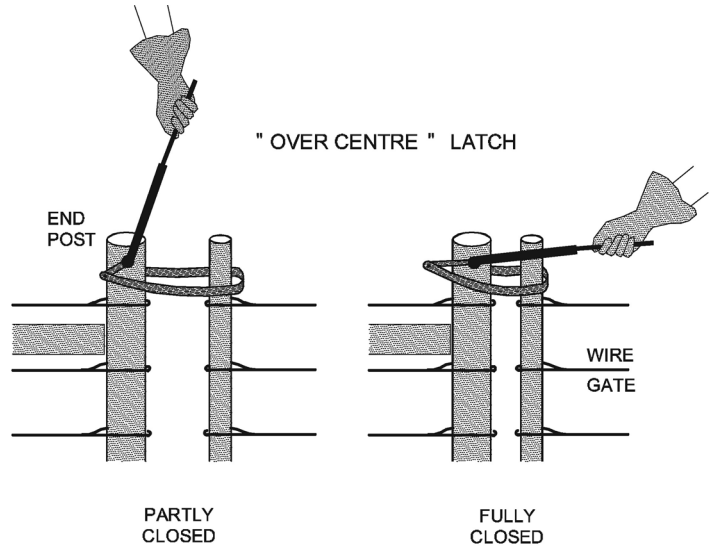
There are as many latch designs as there are kinds of gates on farms. In many cases, they are home-built of materials at hand. Successful latches are convenient to use, retain the gate in position and, where required, are livestock proof. Examples are shown in Figure 4 below.

SLIP WIRE GATE LATCHES

WIRE LOOP WITH LEVER ASSIST

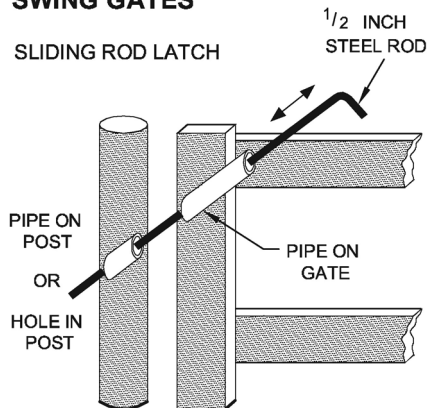


"OVER CENTRE" LATCH

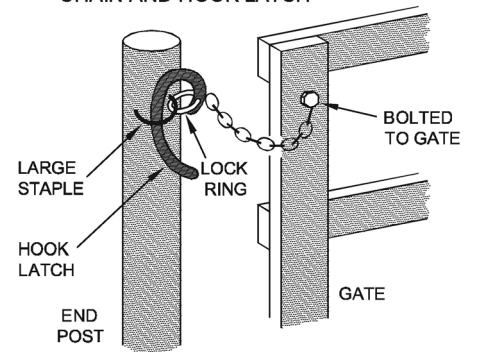


SWING GATES

SLIDING ROD LATCH



CHAIN AND HOOK LATCH



NOTE

THE LOCK RING CATCHES ON THE POST STAPLE TO PREVENT ACCIDENTAL GATE OPENING.

SLIDING BOARD LATCH

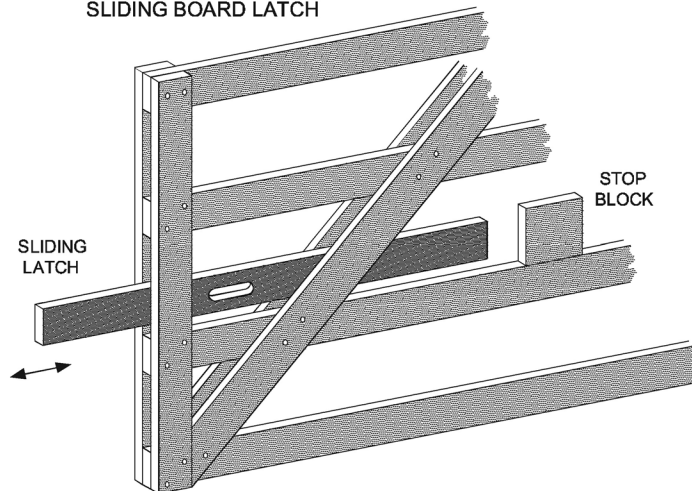


Figure 4

Gate Latches

STANDARD GATES

Wood Gates

Very simple all-wood gates are possible on some fences. A panel of a wood rail fence can be built so the rails slide away for access, as shown in Figure 5. A snake rail fence can be crossed by simply opening up panels and closing after passing. Neither of these would be as convenient as a hinged gate.

Some common wood hinged gates are shown in Figure 5 below. These designs use either round rails or sawn boards and are often seen in cattle handling facilities or corrals.

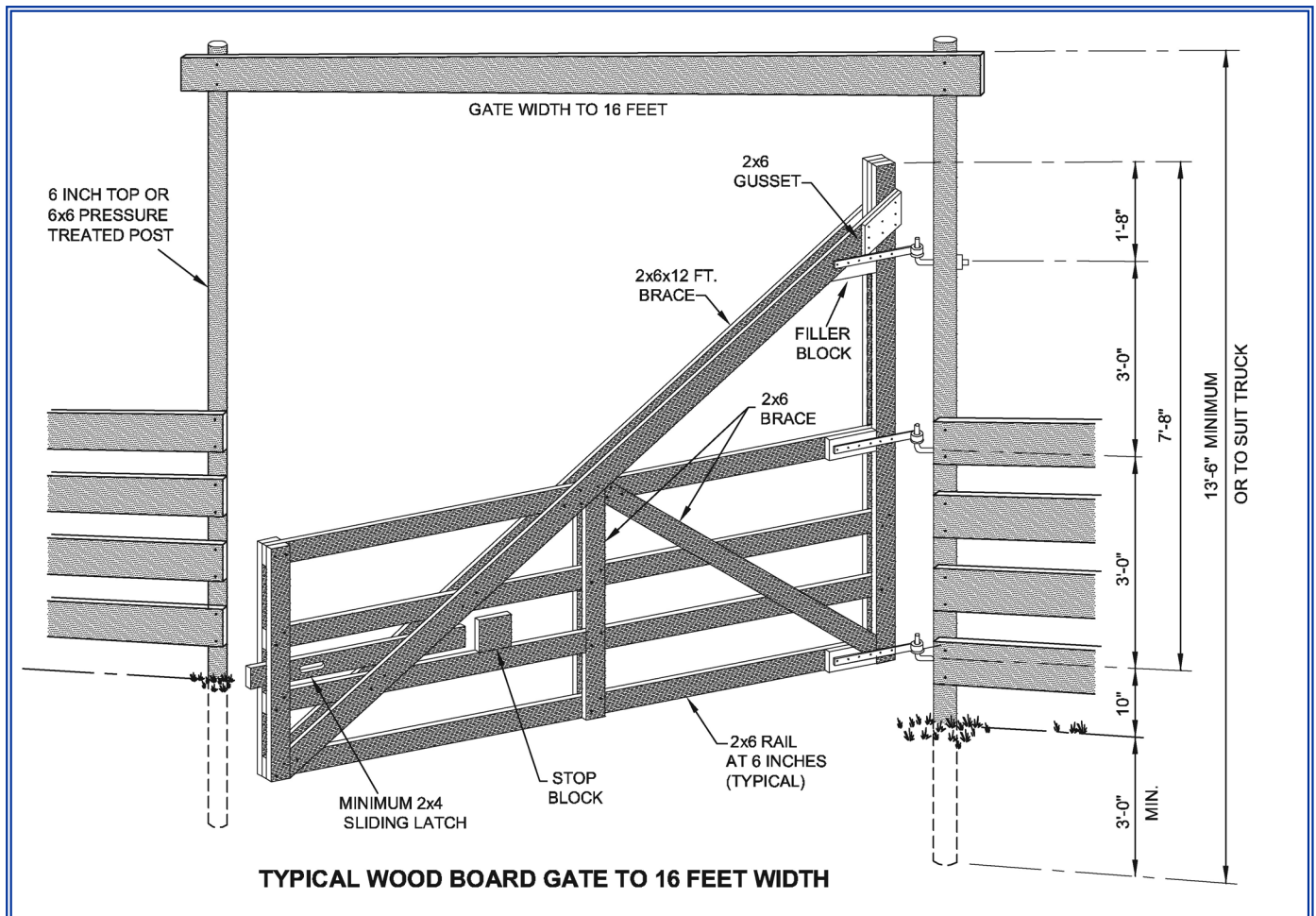
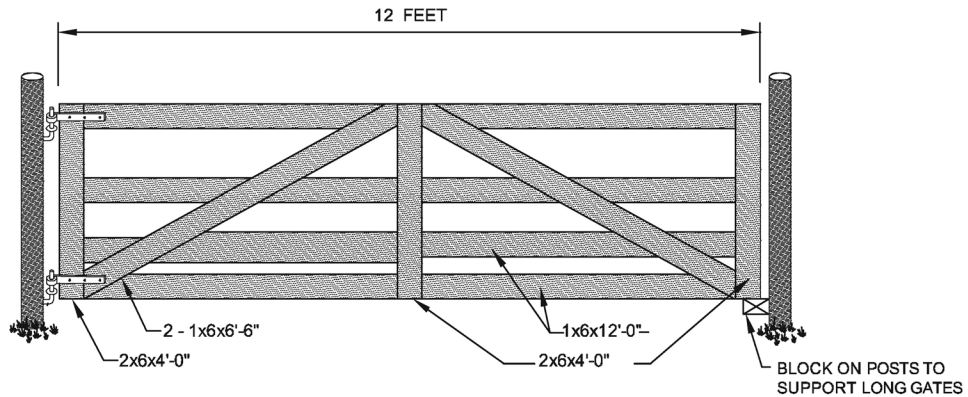


Figure 5

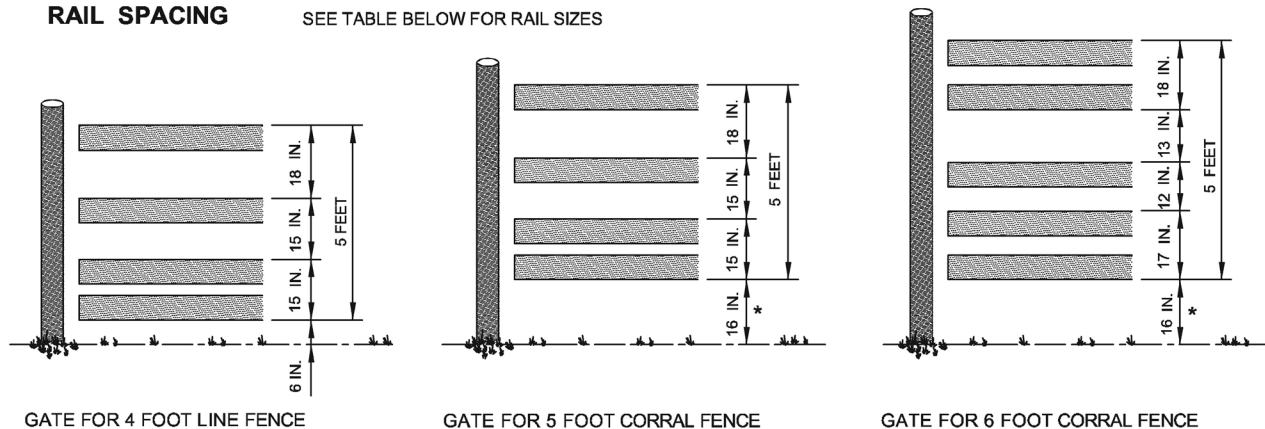
Wood Gates

BRACING



RAIL SPACING

SEE TABLE BELOW FOR RAIL SIZES



GATE CONSTRUCTION - WEIGHT AND RAIL SIZE

GATE USE	GATE HEIGHT	GATE WIDTH					
		10 FT.	12 FT.	14 FT.	16 FT.	18 FT.	20 FT.
LINE FENCE	4 FEET	A/70	B/90	B/100	B/110	C/130	C/140
FEED LOT	4 FEET	A/70	B/90	C/110	C/120	C/130	D/280
CORRAL	5 FEET	B/80	C/180	D/220	D/240	D/260	E/300

RAIL TYPE

- A - 1x4 RAILS
- B - 1x6 RAILS
- C - 1x6 RAILS, DOUBLE RAILS TOP AND BOTTOM
- D - 2x6 RAILS
- E - 2x6 RAILS, DOUBLE RAILS TOP AND BOTTOM

RAIL TYPE / GATE WEIGHT (LBS.)

SOURCE:
MIDWEST
PLAN SERVICE

Figure 5 (continued)

Wood Gates

Wire Gates

Many farm gates are constructed using the same wire as used for the fence, i.e., barbed wire gates in barbed wire fences, woven wire in woven wire fences, etc. Very simple, strand-wire gates have no frame, only wire and a few wooden uprights. These “slip-wire” gates are low cost but tangle very easy and should only be selected for infrequently used gates.

More substantial wire gates have frames of wood or steel that are used to support the wire and are hung on posts similar to wood gates. Because these wire gates are lighter than all wood gates they are often preferred for long spans. Whatever style of wire gate is used, it must be sufficient to match the requirements of the fence.

Hinged Wire Gate

An alternate to a “slip-wire” gate is a simple hinged wire gate. Two uprights on each end of the gate are connected by a rigid diagonal bolted to the bottom of the hinge post upright and the center of the latch post upright. This allows the weight of the gate to pull the wire strands tight. This frame can be constructed of $\frac{3}{4}$ or 1 inch pipe with welded bolting tabs as in Figure 6 below.

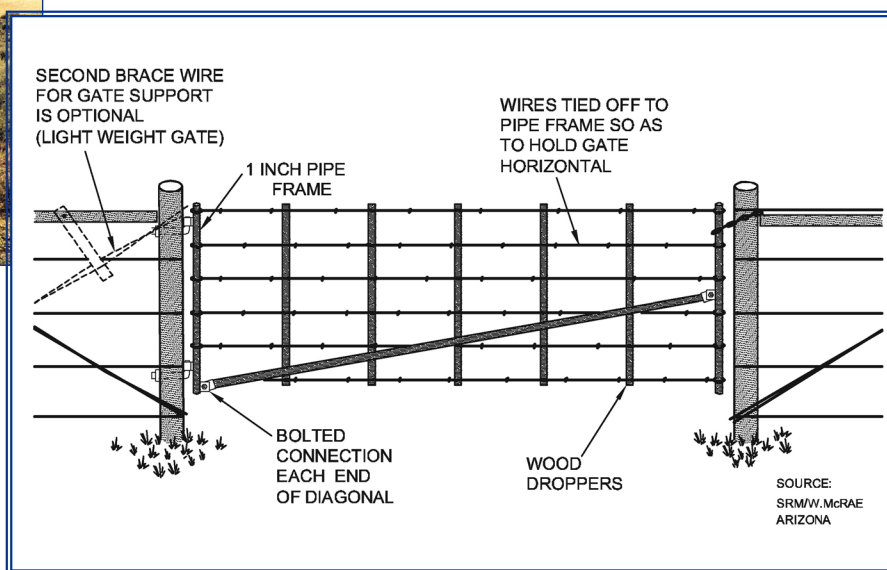


Figure 6

Hinged Wire Gate

Farm-Built Woven Wire Gate

Woven wire fences will often require woven wire gates. These can be purchased commercially or farm built. The gate shown in Figure 7 is built with a steel frame and a means of tensioning the woven wire.

Metal Gates

If a producer wishes to purchase a farm gate, all-metal gates of steel or aluminum are often chosen. As with wire gates, the metal gates are lighter than all-wood gates of the same span and are hung using similar hinges.

Formed aluminum gates are very light and from the standpoint of weathering, they should last indefinitely. However, their strength may not compare favourably to steel or wood gates when exposed to livestock pressure or damage from farm machinery. Figure 8 illustrates a typical formed metal gate.

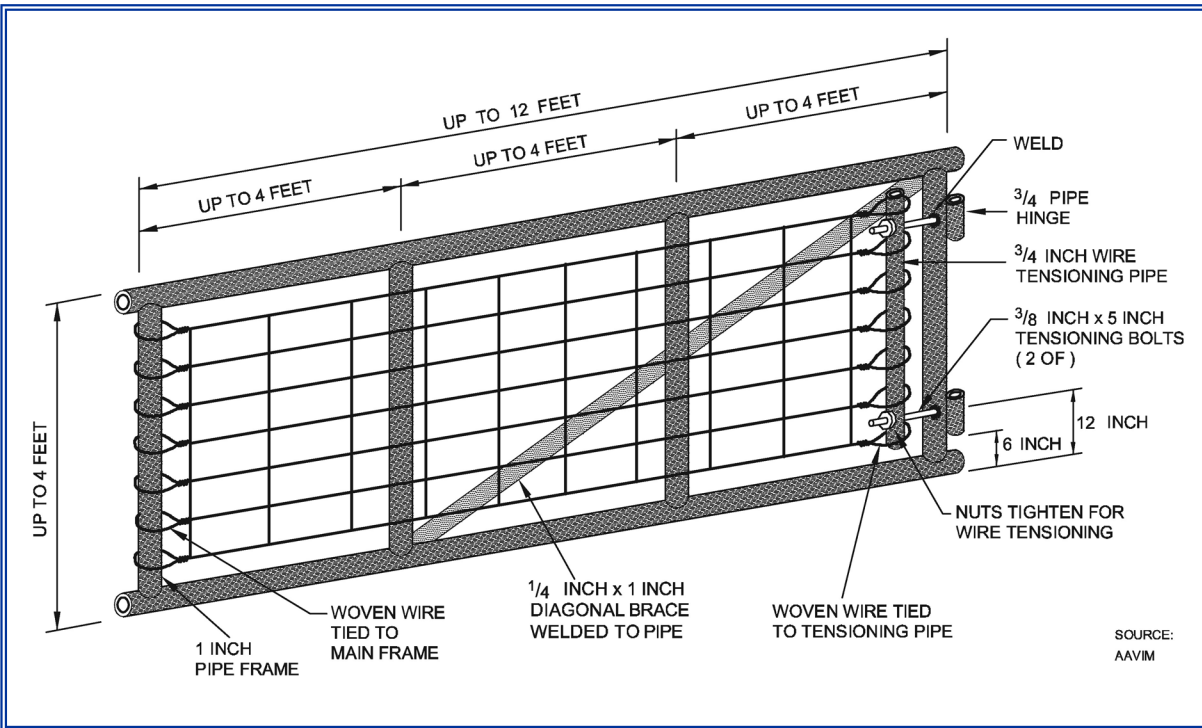


Figure 7

Farm-Built Woven Wire Gate

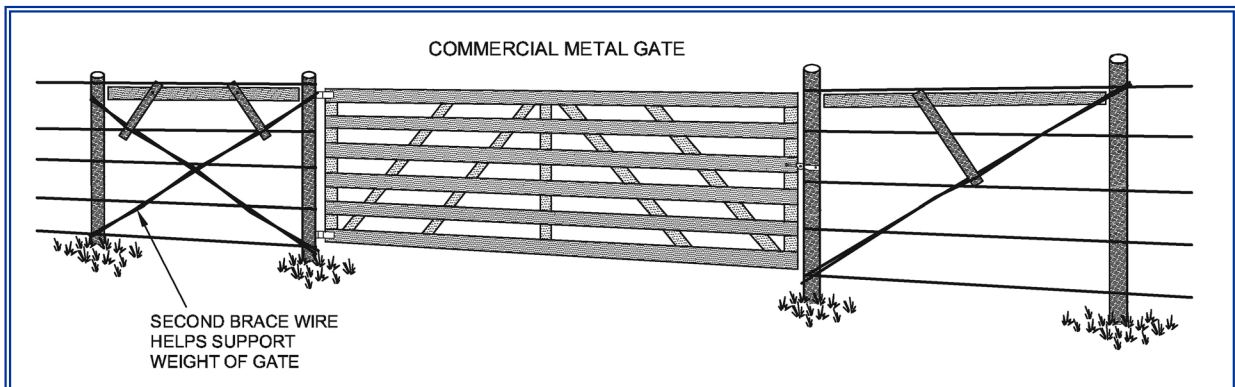


Figure 8

Metal Gate

Electric Gates

Gates in electric fences may be electrified to ensure the effectiveness of the fence but combinations of electric fence and standard gates are also used. In either case, energy from the fence controller must be wired past the gate, either over the gate or buried under it. Wider gate openings may be required to ensure livestock will pass through easily.

Electric Hook Gate

This is the simplest electric gate and is used in a one- to three-strand fence where infrequent passage is required. It consists of an insulated handle with a spring-loaded hook on one end with the other end wired to the gate wire. By gripping the handle, the gate wire is pulled tight and hooked onto a wire loop on the gate post. This loop should be on the supply side of the electric fence. On closing, the circuit is complete and the gate is electrified. When the handle is unhooked the gate is opened and so is the circuit. As the opened gate is not electrified, it may be laid on the ground without shorting the fence. The fence beyond the gate is not electrified when the gate is opened. See Figure 9 below.

Electric Fence / Standard Gate

In many cases, a standard gate of wood, wire or metal will perform adequately in an electric fence and may be more convenient to use. If required, electric wire may be placed on the gate. Figure 10 shows two methods of installing standard gates in an electric fence and routing the wire across the gate opening. Refer to Factsheet No. 307.300-1 entitled *Introduction to Electric Fencing* and Figure 8 for wiring details.

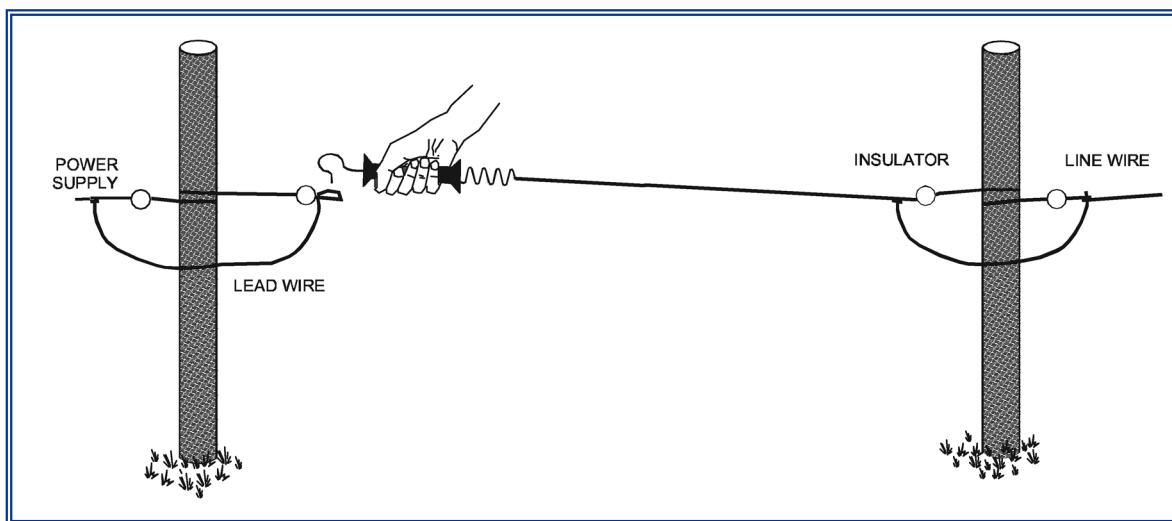


Figure 9

Electric Hook Gate

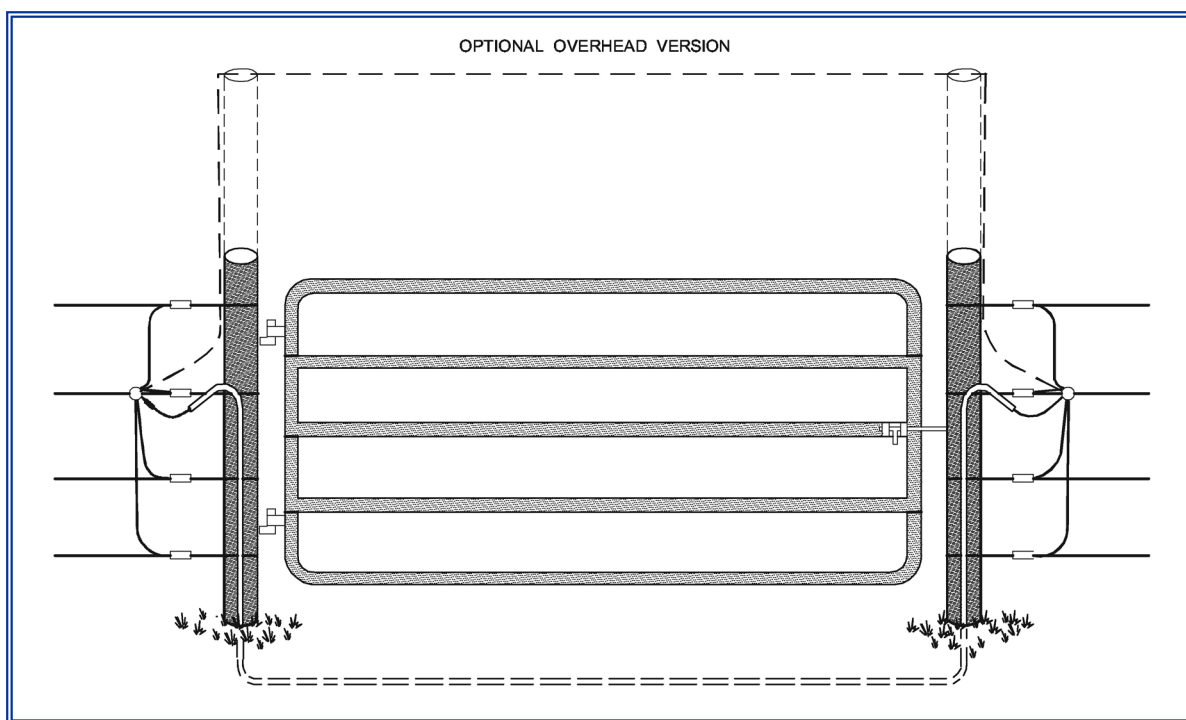


Figure 10

Electric Fence / Standard Gate

SPECIAL GATES

Cattle Guards

Cattle guards, or Texas gates, are designed to allow easy passage of vehicles while containing livestock. Although termed “cattle” guards, they are effective on most domestic animals. They may be installed adjacent to standard hinged gates where livestock passage is also required. Cattle guards are incorporated for convenience and are normally installed in fence lines where vehicle passage is frequent. This convenience must be weighed against any additional cost or maintenance of cattle guards over standard gates.

Cattle guards require side framing to be secure. These framing rails run from the fence and posts down to the ends of the cattle guard.

Cattle guards have not proven effective in controlling wildlife, such as keeping deer out of orchards and hay fields. Tested in conjunction with deer exclusion fences, guards 10 feet wide and up to 24 feet across using 1/2 inch steel plate on edge spaced 4 inches apart did not repel deer. Full size swing gates may be the only alternative in these cases.

Cattle Guard Design

Cattle guards work on the principle that most livestock lack depth perception and by constructing an open slatted crossing over a pit they will not cross it. Painted white stripes on black pavement have been known to contain cattle.

In addition, the cattle guard slats are chosen to be difficult for livestock to walk on. Because these slats must be raised off the ground, a pit or cavity is formed which must be kept clear of silt and debris. This usually requires some annual maintenance.

Temporary or Portable Cattle Guards

If a cattle guard is required for only a short period of time, low cost temporary designs are used. They are less convenient to cross than permanent guards but are easy to install.

One design is a raised wood or steel platform with an approach ramp at each end that is set on the existing road surface. No road excavation is required. This rigid platform must be strong enough for the vehicle traffic. It is removed to clean out accumulated dirt and debris. Refer to Figure 11 below.

Another temporary design is also raised above the road bed but has no approach ramp. Instead it “springs” down when driven on. It may have a shorter life than the previous design but should be lower in cost, as well as lighter and more portable. See Figure 12.

Permanent Cattle Guards

These designs use either pressure-treated wood or steel and concrete for long life. They may be installed as a “bridge” over a ditch line or with raised road bed approaches on both sides. Either way, good access for cleanout is important. In difficult situations, the cattle guard may be installed at road level over a dug pit. Sections must then be lifted out to clean the pit.

A well-constructed permanent cattle guard will be a minimum of 6 to 8 feet long (end to end) and 10 to 16 feet wide (from side to side) over a two-foot deep pit with good clean out access. A cattle guard design is shown in Figure 13.

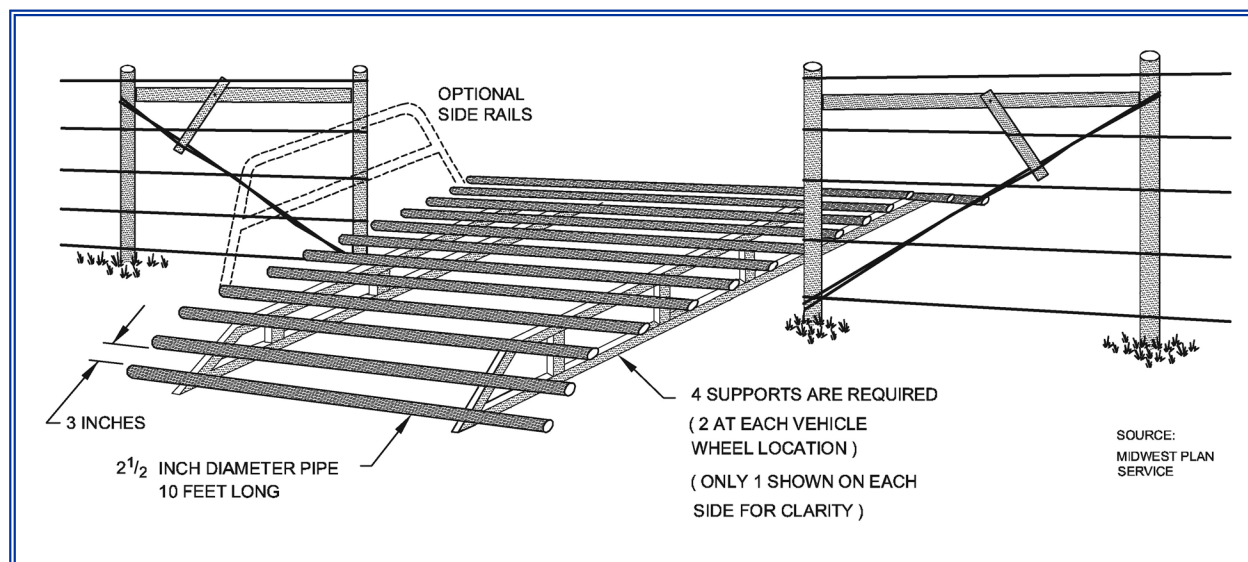


Figure 11

Rigid Temporary Cattle Guard



Figure 12 **Spring-Supported Temporary Cattle Guards**



Figure 13 **Permanent Cattle Guard**

Wildlife Gates

Wildlife fencing may not be 100% effective. Should animals cross a fence, an easy exit is required in the form of a one-way gate. These function only to release animals from a farm or orchard but do not allow entry. They are commonly seen on the Coquihalla Highway, for example, for moose and deer escapes from the road right-of-way.

Design and Installation

The gate must have one-way action, be very easy to activate, and be easily located by the animal. Gate location is important if the animal is expected to use it. Two general methods are shown in the orchard drawings in Figure 14 below. Either the fence line at the gate should be offset or the fence should be 'funneled' toward the gate. These locations are effective because the animal will follow the fence line right to the gate.

The photograph in Figure 14 below is a highway right-of-way installation.

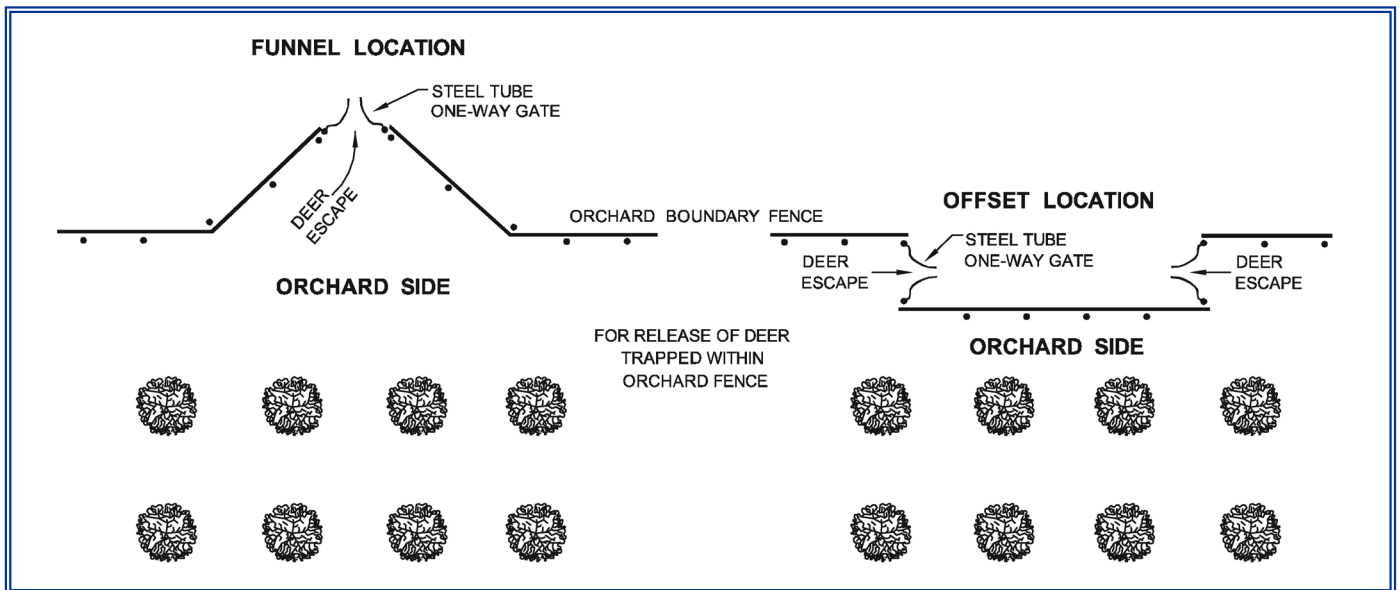


Figure 14

Wildlife Gate Locations

A typical one-way gate is constructed of two sets of curved tines that are mounted vertically on spring closed hinges. The tines curve away from the enclosure side of the fence to the outside as shown in Figure 15 below.

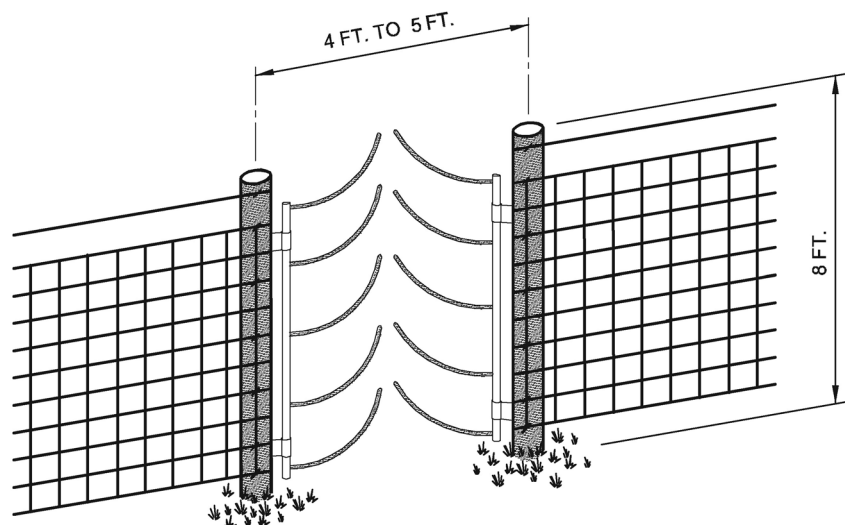


Figure 15

One-Way Wildlife Gate

Passageways

Passageways are fence crossings to allow human passage only. They include hinged gates, stiles, ladders, walkthroughs, stepovers and safety passes as shown in Figure 16 below. They must be safe, strong, easy to use and livestock proof.

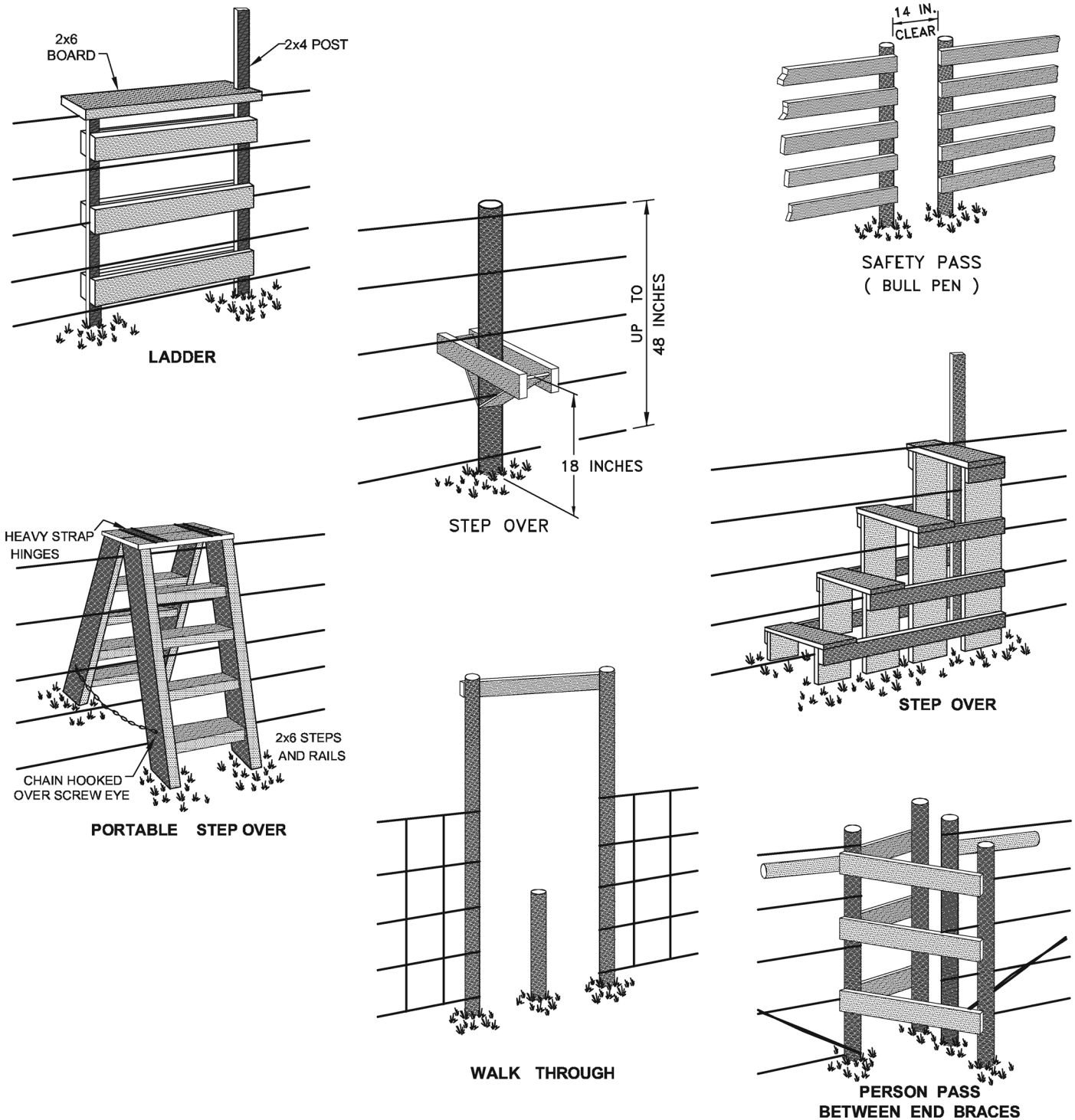


Figure 16

Passageways

Flood Gates

When fencing across small creeks or seasonal drainage gullies, it is sometimes necessary to install flood gates. These self cleaning devices will block animal movements at low water but ensure passage of water at peak flows. While various materials can be used, panels of treated wood are economical and functional. Suspended from a double wrap of high tensile smooth fence wire or light cable, wood battens are assembled to the shape of the water course. Wide flood gates will require bracing of the two line posts as shown in Figure 17 below. In the case of electric fences, the flood gate can be constructed of woven wire and can be electrified (only during low water) using a flexible spring connector.

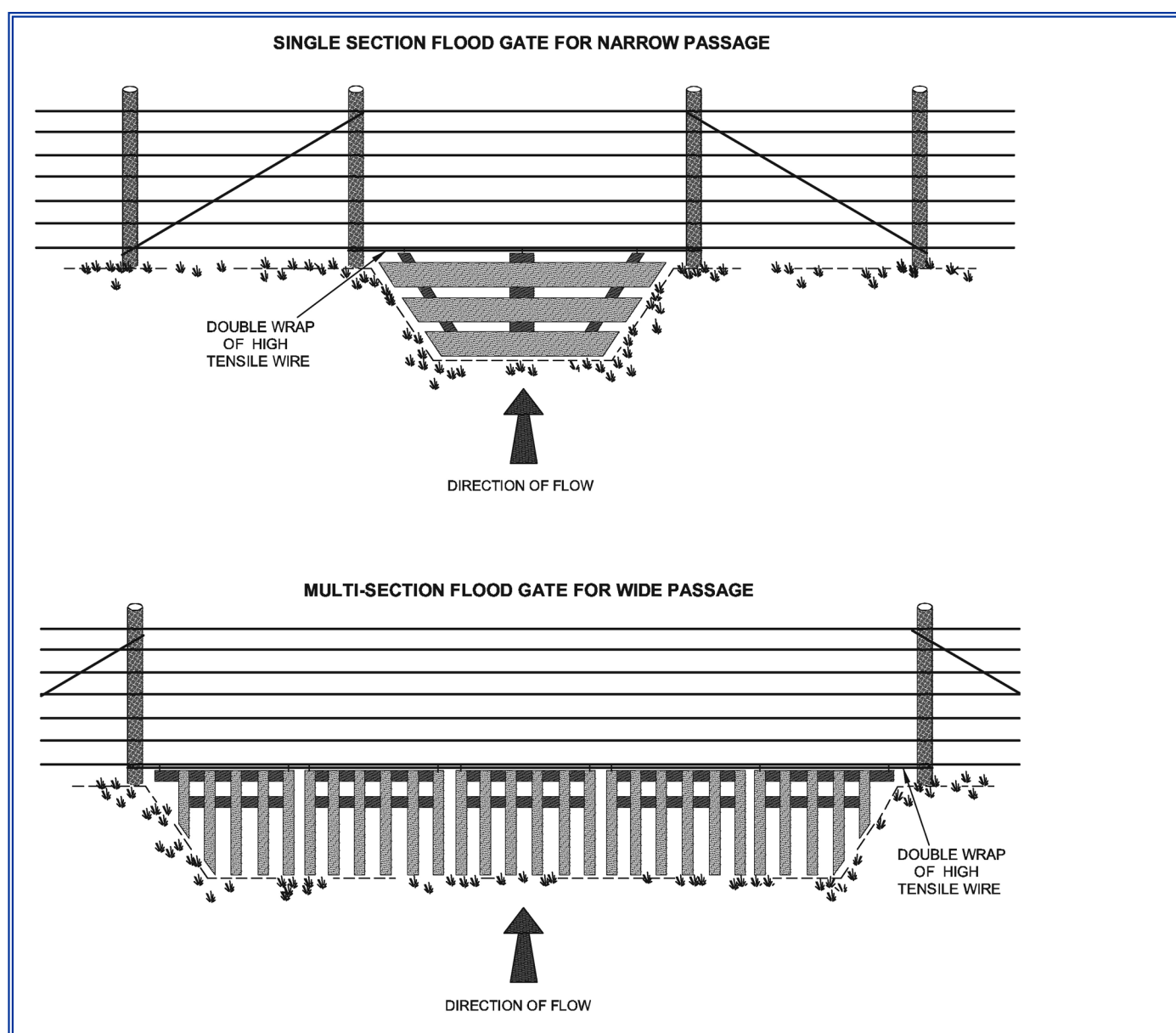


Figure 17

Flood Gates

Invisible Gates

A unique gate is available that uses electronic technology. A light beam is projected across the gate opening that triggers an alarm when interrupted. The livestock are frightened away from the opening by the combined sound and flashing light of the alarm. A button can be pressed to deactivate for passage as required.

FOR FURTHER INFORMATION CONTACT

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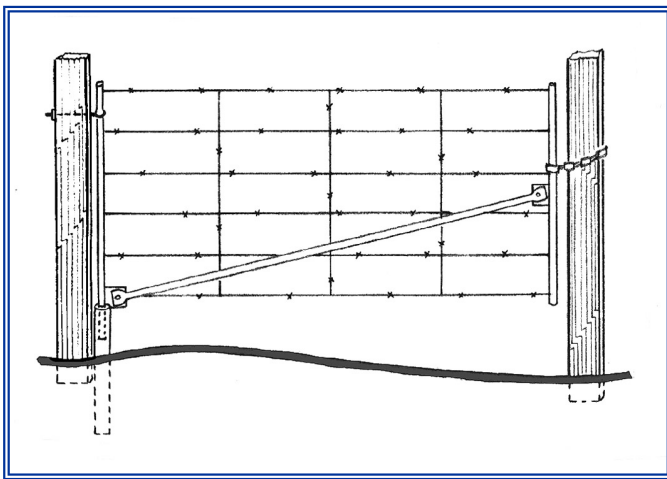
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Fencing FACTSHEET

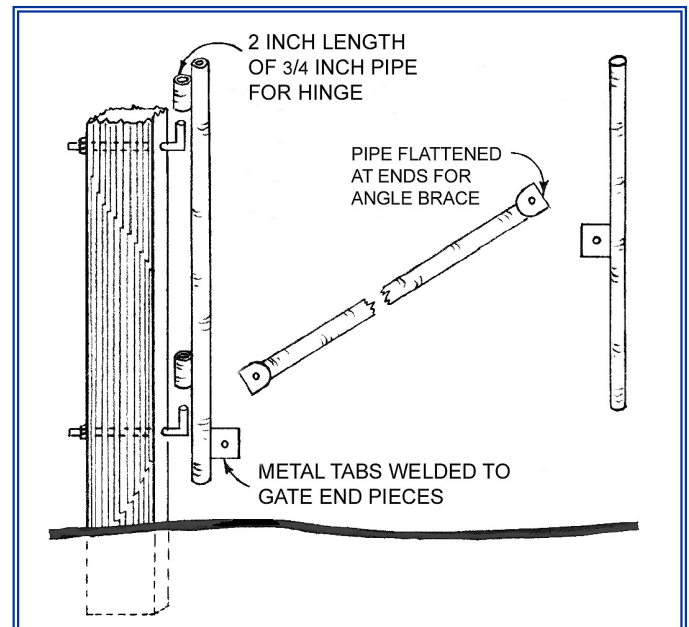
HINGED WIRE GATE

This is an improvement over inexpensive wire gates that are not freestanding and often tangle when opened. With the addition of the rigid diagonal bar from the bottom of the hinge end to the centre of the latch end, the wires are kept taut. This diagonal must be stiff enough to support the gate without sagging or twisting and the bolted joints between the diagonal and the ends must be tight to hold the latch end vertical. These bolted joints allow adjustment in the angle of the diagonal so the gate can be set on level or sloping ground.



To assemble the gate, fasten the end pieces to the diagonal, hang it on the hinges, then fasten the first wire from the centre of the latch end to the centre of the hinge end. This should be tightened to hold the latch end at the desired height. Pull the other cross wires tight enough to hold the latch end vertical and put in vertical supports as required. As in most presently used wire gates, a loop of chain, etc., will act as a latch. Heavy gate posts are not necessary as the gate is relatively light. Gate width can be up to 4.8 or 5.5 meters (16 to 18 feet).

Materials for the diagonal and ends can be steel pipe (galvanized or painted to prevent rusting), wooden rails or a combination of the two. The ends will be standard for any width of gate with only the diagonal varying in length. The hinge can be two bolted pivots on the gate post or one on the post and a buried pipe in the ground. The joints of the diagonal to the two ends can be accomplished in a number of ways from welded tabs to screwed-on angle iron brackets for wooden components. Whatever components are used, it is important to have a tight joint to hold the latch end vertical.



(This information was presented in an issue of *"Rangelands"* by S. Clark Martin, University of Arizona).

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